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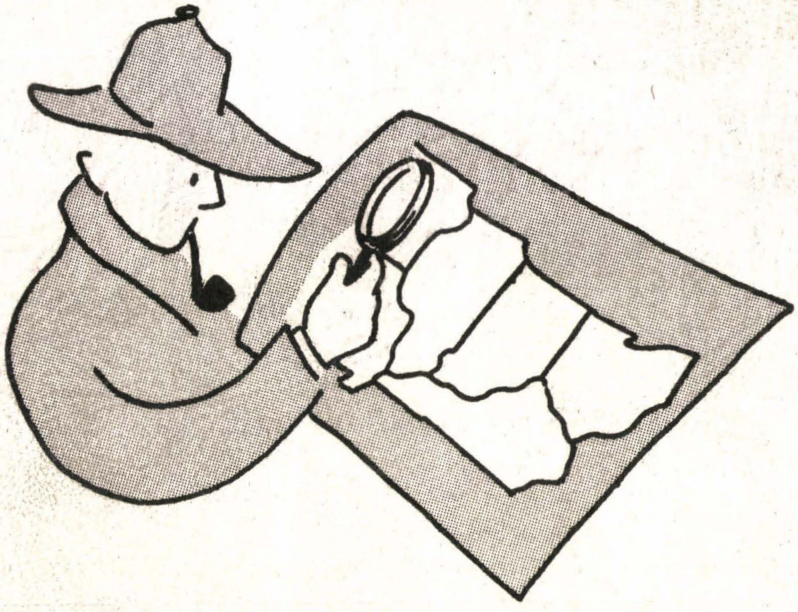
Inspectors'-Eye View

of the

Central States Station

1960



The material assembled here was originally prepared for the inspectors who participated in the 1960 General Integrating Inspection of Region 9 and the Central States Station. However, because this material summarizes the Station's objectives, obstacles to be overcome, and functional program so well, I thought it would be a good idea for each staff member to have a copy for reference.

R. E. Lane

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STATION OBJECTIVES

The broad Station objectives are listed below without reference to priority. Some of these, such as training, will require continuing effort while others, such as improving Station quarters, may be accomplished within more specific time goals. In general, our objectives should be reached or strong progress made within the next five years.

1. Work with R-9, R-7, the state and extension foresters, the universities and other public or private groups to obtain greater application of improved multiple forest land use practices. Emphasis will be given to the heavily forested sections where forest lands can play a more significant role in the local and national economy.

2. Strengthen and expand the Station's relations with all public and private forestry groups in the six Central States.

3. Strengthen the Station's position as the leading forestry research organization in the Central States by: (a) improving and expanding the Forest Service research program; (b) solving high priority regional research problems; and (c) cooperation, participation, and correlation with other research groups in forestry and related fields.

4. Review regional research needs and the Station's program with the objectives of: (a) gearing our program to major regional research needs; (b) establishing goals for orienting the research program and organization to Forest Service Research policies; and (c) taking positive steps to reach the goals established.

5. Work with the Chief's office to meet the program expansion goals set by the National Forest and Non-National Forest programs. Specifically, to accomplish the short-term $2.6 million research program assigned the Central States Station.

6. Create and maintain a research atmosphere that is stimulating to the individual scientist and conducive to the maximum research accomplishment by the Station.

7. Improve the training of each Station employee, using every means available.

8. Obtain and occupy better Station quarters.

9. Provide Station scientists with adequate supporting services, personnel, equipment and safe working conditions.

OBSTACLES TO GREATER RESEARCH ACCOMPLISHMENTS

We consider the following to be the major obstacles to greater research accomplishments.

1. Public apathy toward: (a) the multiple values of the forest land resource; (b) the impact of destructive agents ravaging the forest resources; and (c) the significant role forest land can play in local and regional economy.

2. The relatively low quality of our present timber resource, the low level of management practiced; archaic conditions in the wood-using industry, and the shortage of bulk-material markets.

3. Lack of a coherent, integrated approach to major forest research problems among the many groups conducting research in the region.

4. Inadequate offices, research equipment, facilities, and supporting services.

5. Shortage of fully trained scientists in many disciplines as well as of supporting technicians and sub-professionals.

6. The ever-increasing costs of "doing business."

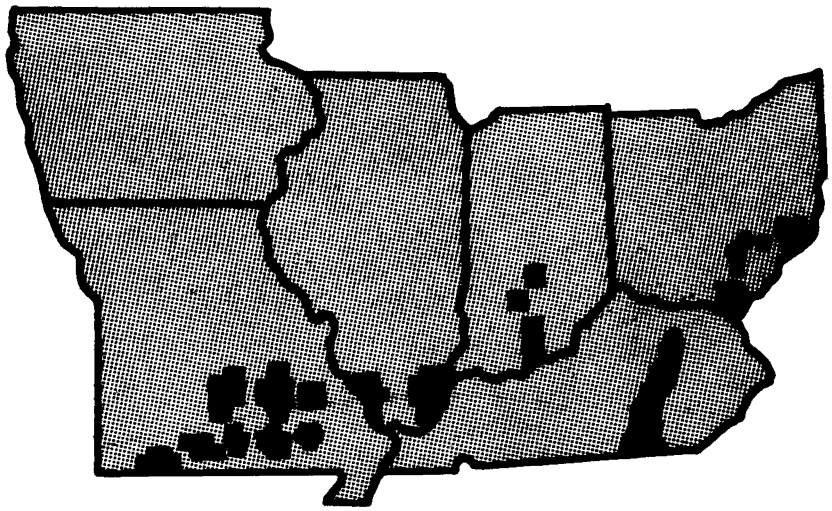
7. Delays in research and development in supporting or associated fields.

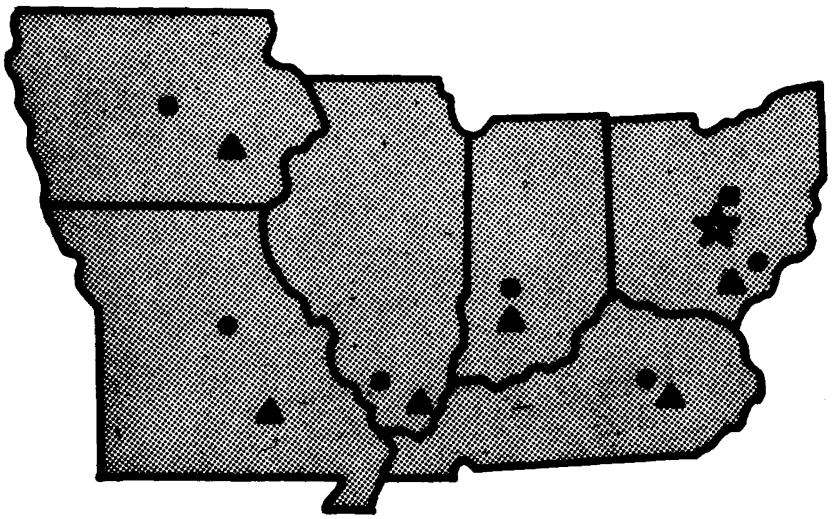
Research and Field Stations of the Central States Forest Experiment Station

	Location	Officer-in-Charge
Forest Insect Laboratory	Delaware, Ohio	R. Whitten
Forest Disease Laboratory	Delaware, Ohio	C. Seliskar
Ames Research Center	Ames, Iowa	G. Deitschman
Amana Experimental Forest	Amana, Iowa	A. Green
Athens Research Center	Athens, Ohio	B. Roach
Vinton Furnace Exp. Forest	McArthur, Ohio	---
Berea Research Center	Berea, Kentucky	M. Williamson
Bald Rock Exp. Forest	Berea, Kentucky	---
Carbondale Research Center	Carbondale, Ill.	R. Merz
Kaskaskia Exp. Forest	Elizabethtown, Ill.	R. Ryker
Wood Products Pilot Plant	Carbondale, Ill.	J. Micklewright
Columbia Research Center	Columbia, Mo.	R. Ralston
Sinkin Exp. Forest	Salem, Mo.	N. Rogers
Springfield Field Office	Springfield, Mo.	K. Seidel
Ohio Watershed Field Office	New Philadelphia, O.	R. Whipkey

THE CENTRAL STATES FOREST EXPERIMENT STATION AREA

NATIONAL FORESTS





RESEARCH INSTALLATIONS

★ Headquarters

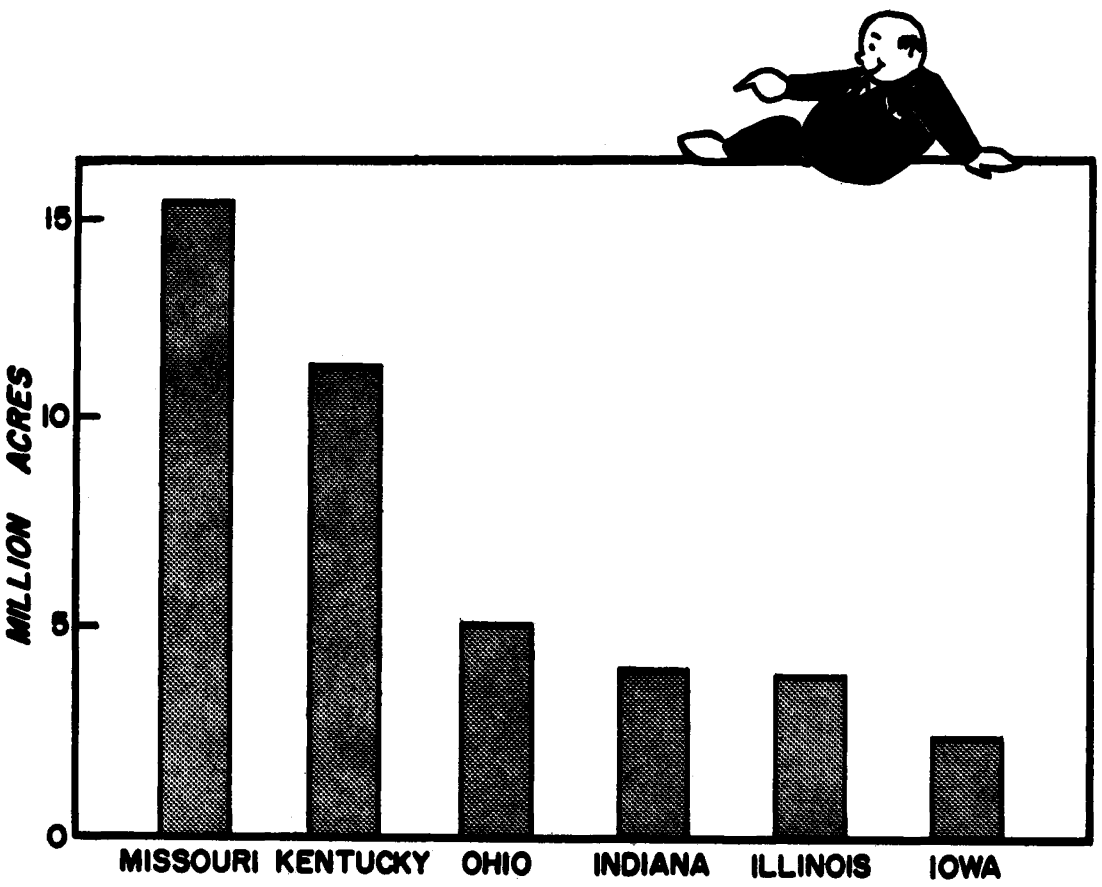
● Research Center

▲ Experimental Forest

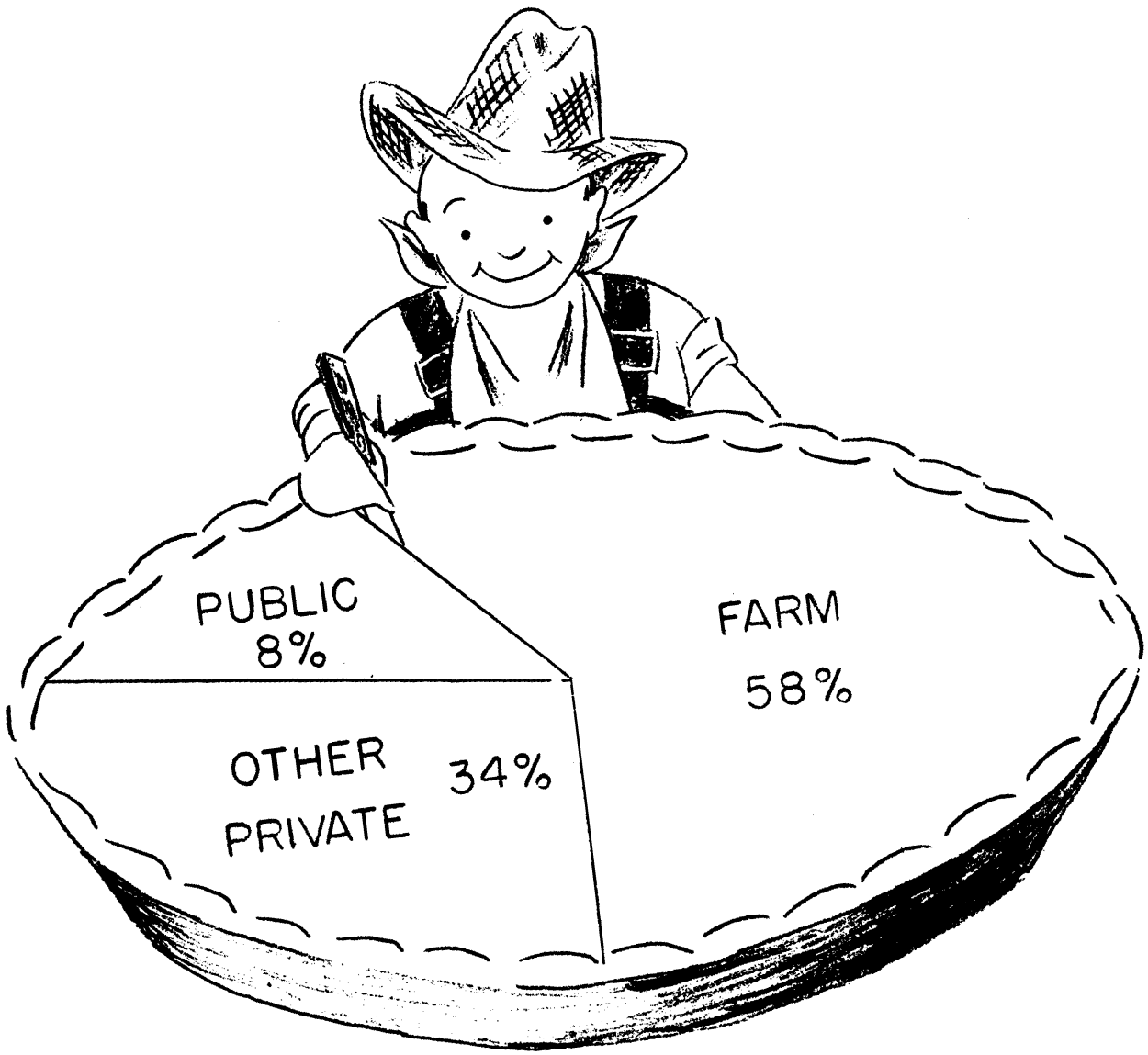
■ North-Central Forest Biology Laboratories

FORESTS IN THE CENTRAL STATES AREA

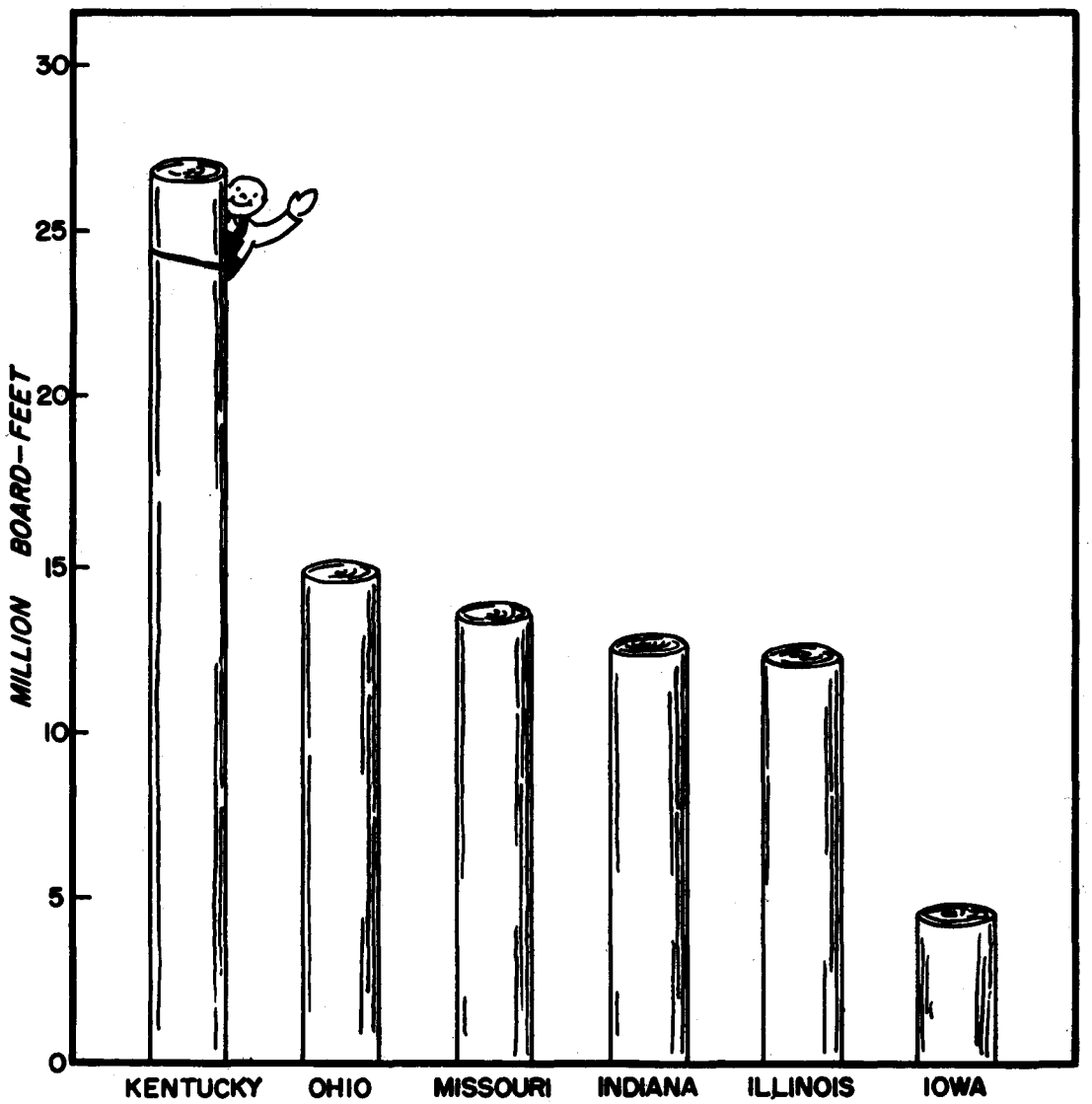
There are 42.7 million acres of forest land. More than 1 out of every 5 acres of land is forested. Missouri has more than one-third of the forest land.



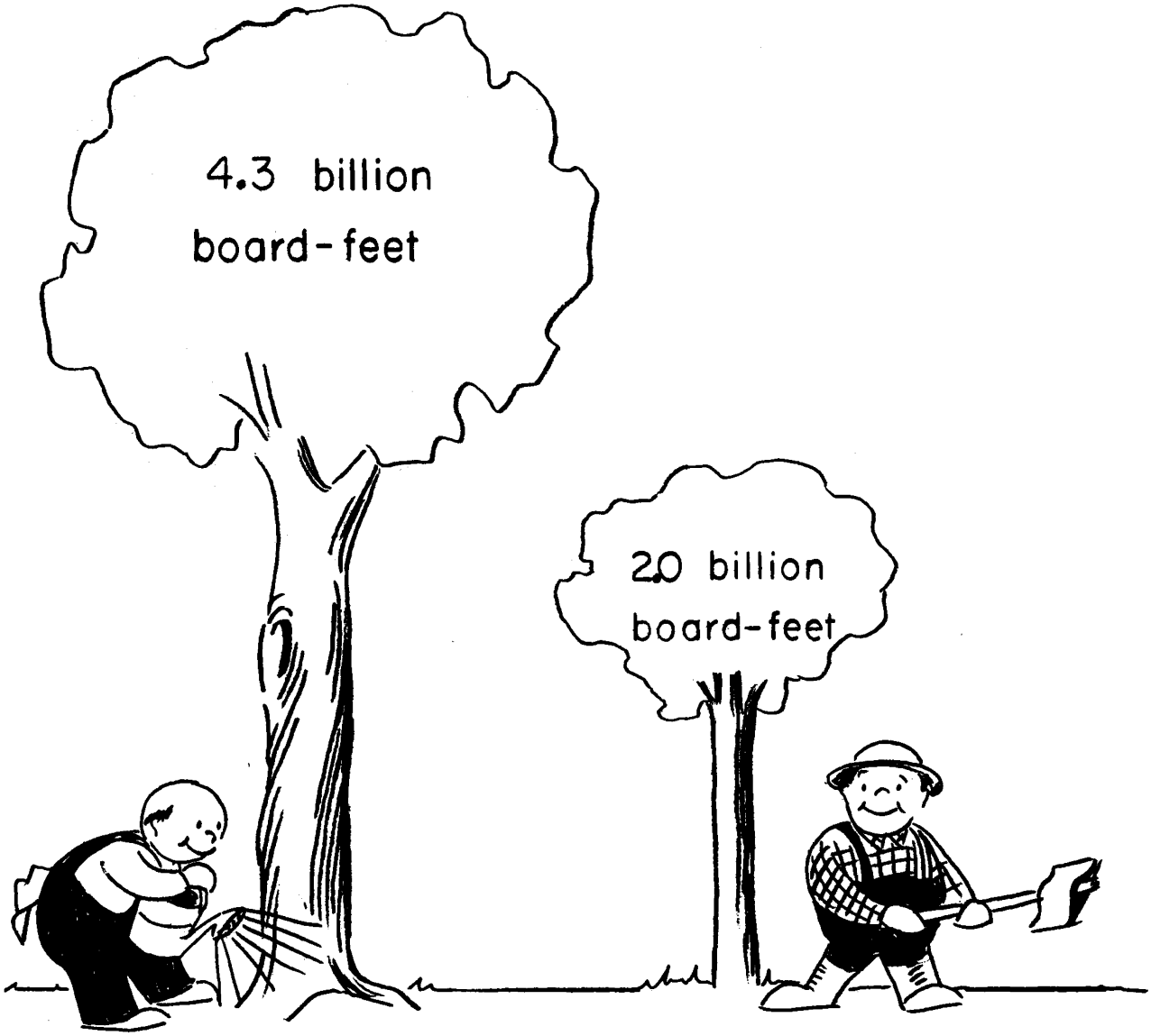
More than 600,000 farmers own 58 percent of the forest land.



How much timber is growing on this area? More than 83 billion board-feet. Kentucky has nearly one-third of the saw-timber.



We grow more than twice as much wood in a year than we cut.



Looks good, doesn't it? Only trouble is, if we take a closer look we find that we're cutting mostly good timber and leaving the poorer stuff to grow. This means that a good part of this growth is being wasted on poor species and defective trees.

Volume of Sawtimber in Central States Area
(In million board feet)

State	Total			Sawtimber stands			Other stands			Net annual growth	Annual cut
	All species	Soft-wood	Hard-wood	All species	Soft-wood	Hard-wood	All species	Soft-wood	Hard-wood		
Illinois	11,694	44	11,650	10,311	43	10,268	1,383	1	1,382	496	173
Indiana	11,982	55	11,927	11,037	45	10,992	945	10	935	610	269
Iowa	4,119	--	4,119	3,374	--	3,374	745	--	745	219	127
Kentucky	27,342	2,167	25,175	23,630	1,791	21,839	3,712	376	3,336	1,410	695
Missouri	13,195	809	12,386	6,406	518	5,888	6,789	291	6,498	785	448
Ohio	14,901	352	14,549	13,351	279	13,072	1,550	73	1,477	807	281
Total	83,233	3,427	79,806	68,109	2,676	65,433	15,124	751	14,373	4,327	1,993

Estimated Output and value of primary forest products in the central states area, 1958

State	Sawlogs	Veneer logs[1]	Cooperage logs[1]	Pulpwood[1]	Fuelwood	Posts	Mine timbers	Other	Total value
	M bd. ft.	M bd. ft.	M bd. ft.	cords	cords	M pieces	M cu. ft.	M cu. ft	Thousand dollars
Illinois	110,000	9,050	24,714	64,000	260,000	5,000	750	932	12,739
Indiana	180,000	9,918	3,336	25,000	345,000	4,600	400	1,009	16,445
Iowa	60,000	6,438	1,497	15,000	313,000	2,400	-	-	8,019
Kentucky	480,000	12,098	22,256	35,000	840,000	13,000	5,000	3,521	37,340
Missouri	320,000	7,032	30,806	12,000	905,000	16,000	1,000	3,224	24,015
Ohio	225,000	8,035	8,579	141,000	330,000	4,500	200	2,833	18,443
Total	1,375,000	52,571	91,188	292,000	2,993,000	45,500	7,350	11,519	
Total value (in thousand dollars)	52,400	6,025	6,796	3,597	23,644	20,330	1,355	2,854	117,001
Average value (per unit)	38.11	114.61	74.53	12.32	7.90	446.81	184.35	247.76	

1/ Data from stationwide production canvasses.

Central States Forest Areas

(in thousands of acres)

State	Total forest area	National forests (6/30/59)	Farm woodlands
Illinois	3,993	211	3,050
Indiana	4,103	119	2,878
Iowa	2,510	4	2,321
Kentucky	11,497	459	4,903
Missouri	15,177	1,361	8,498
Ohio	5,446	107	3,047
Total	42,726	2,261	24,697

Forest Area by Stand Size in the Central States

(in thousands of acres)

State	Sawtimber[1]	Poletimber[2]	Seedlings & saplings[3]	Nonstocked[4]
Illinois	1,823	981	729	405
Indiana	2,084	1,337	600	24
Iowa	903	909	341	352
Kentucky	4,964	4,040	1,830	612
Missouri	2,033	6,477	4,778	1,776
Ohio	2,679	1,978	679	60
Total	14,486	15,722	8,957	3,229

1/ Sawtimber stands.--Stands having a net volume of 1,500 or more board feet per acre in sawtimber trees.

2/ Poletimber.--Stands failing to meet the sawtimber-stand specifications, but at least 10 percent stocked with poletimber and larger trees and with at least half the minimum stocking in poletimber trees.

3/ Seedlings and saplings.--Stands not qualifying as either sawtimber or poletimber stands but having at least 150 seedlings and saplings of commercial species per acre.

4/ Nonstocked.--Commercial forest land not qualifying for any other class.

September 1960

FOREST ECONOMICS RESEARCH AT CENTRAL STATES FOREST EXPERIMENT STATION

CURRENT RESEARCH

Forest Economics Research at the Central States Station is charged with: (a) developing new or expanded markets for forest products; (b) investigating timber processing and marketing methods to improve efficiency; (c) providing more information on the costs and returns of growing and marketing timber; and (d) assembling data on forest resources and industries to measure demand and supply trends. Special emphasis is given to the problems of the 900,000 small woodland owners in the Central States. Specific studies are listed below.

1. Timber Marketing.--(a) determining trends and relationships for rough forest products prices in Ohio, (b) developing and coordinating timber price reporting services throughout Central States, (c) determining the feasibility of establishing new wood-using industries in eastern Ohio, and (d) determining profit margins obtained by sawmill operators following standard commercial practices, their productivity by mill class and the effectiveness of FPL log grades in predicting value of lumber sawed by commercial mills.

2. Production Economics.--(a) evaluating yields, management costs, values and market opportunities for timber on various

sites, different levels of stocking, and under different management methods in the Missouri Ozarks, and (b) studying the relationships between forest conditions and forest owner characteristics on small forest tracts.

3. Forest Survey.--(a) surveying and reporting on production of pulpwood, veneer, lumber, staves, and other round forest products in the Central States, (b) analyzing and reporting on the current Missouri forest resource inventory, (c) assisting in planning the resurveys of Illinois and Kentucky, and (d) advising wood-using industries and others as to availability of the forest resource.

4. Cooperative work with:

   A. Purdue University.--Measuring growth and yield on Indiana farm woodlands with different intensities of management.

   B. University of Kentucky.--Studying use of hardwood lumber products in residential construction in the Lexington, Kentucky area.

   C. North Central Agricultural Experiment Stations Regional Project NCM-27, (Missouri, Iowa, Illinois, Indiana, and Ohio). Evaluating the effectiveness of present timber marketing practices of primary wood manufacturers, intermediate agents and timber producers in selected areas in the Central States.

MAJOR CONTRIBUTIONS OF COMPLETED RESEARCH

1. A market development study indicated that the demand for pine fence posts and poles was expanding rapidly in northwest Missouri and similar areas and that pine timber from the Missouri Ozarks was suitable for this market and was easily accessible. However, but few pine posts and poles were being harvested in the Ozarks. Two reports describing this situation were published. Four years later, pine post production in the Missouri Ozarks had increased one hundred fold, and pine pole production had become an important industry.

2. A felling and bucking study showed that by bucking to get optimum log grade and by more complete utilization of the stem loggers could increase: (a) the volume in better grades of logs by 10%; (b) total net volume by about 5%; and (c) the operator's margin for profit and risk by 100%.

3. Annual or biennial surveys have been initiated to report production of pulpwood, stave timber and veneer timber in the Central States to record developments in these industries.

4. Timber price reports were perfected in Ohio to the point that they could be taken over by the Agricultural Marketing Service on a quarterly basis, thus answering the timber producers' and buyers' needs for current prices.

5. A market study in Kentucky showed how much each step or process in wood-products manufacture increased product value (returns to the community) and margin for profit of the operator. For example; plants using two million board feet of timber but carrying their manufacturing to different products may be compared as follows:

Plant Production	Product Value	Margin for Profit
	----------Dollars----------	
Rough green lumber	123,000	19,000
Air dry lumber	144,000	19,000
Pallets	208,000	24,000
Millwork (Paneling, molding, trim)	256,000	30,000
Flooring	278,000	31,000

The results show communities specializing only in timber growing and shipping primary products out for further manufacture lose much of the potential earning power of the raw wood.

NEW RESEARCH OPPORTUNITIES

Listed below are what we consider to be the major opportunities for Forest Economics Research to contribute to improved forest production and to better living for the people of the Central States.

1. Provide facts needed to improve the movement of lumber and lumber products through existing market channels and agents in Eastern Kentucky, the Southeast Ohio hill country and the Missouri Ozarks.

   Present methods are inefficient and make only minor contributions to the local economy. The counties in these areas are all over 40 percent forested and many are over 80 percent forested (fig. 1). Rough lumber is the major timber product marketed (fig. 2 and 3). It is usually shipped to large industrial centers outside these areas for further processing and fabricating. The market is characterized by repeated handling, many transfers of title, small scale production and ineffective distribution practices.

2. Appraise and report on the feasibility of expanding primary wood-using industries to provide more adequate markets for the hardwood pole timber resource and pine plantations in the Central States.

Many areas of a logical size (50-mile radius) to supply the timber resource base for a hardwood fiber industry have an annual increase in merchantable cordwood volume of 300,000 to 500,000 cords (fig. 4 and 5). One of the major deterrents to good management in the Central States is the lack of markets for hardwood cordwood size timber.

Over a half a million acres of pine plantations have been established in the Central States and many plantations now must be thinned if they are to maintain optimum growth and show a net profit to their owners. Further, it is estimated that an additional 8 million acres in the Central States need planting. This is about 14 percent of the plantable area in the United States. Unless markets become available for plantation trees now of commercial size, the task of getting the 8 million acres of idle land into production will be delayed or postponed indefinitely.

3. Evaluate and develop guides as to investment and alternative opportunities for timber owners in stand improvement, thinning, harvesting and marketing of our mixed oak pole and sawtimber stands.

Little is known today as to precisely what forestry pays under alternative methods of timber management; as a result timber owners cannot be properly advised.

Production data are seldom available, nearly always require assembly or reassembly on an estimation basis, frequently cannot be converted to useful form and often are applicable only to scattered locations and special circumstances. Man and equipment time to perform forestry practices commonly are inadequately documented and yield, volume table and growth data are lacking in many areas. Cost data are seldom available for common forestry tasks and practices. Formal studies are required to assemble, analyze, catalogue, and interpret input-output data throughout the region and to supplement them where necessary.

4. Determine the motivations needed to induce owners of small forested tracts to increase the productivity of their timberland.

Approximately 900,000 private individuals own forest land in the Central States (fig. 6). Most of them own less than 100 acres each, do not manage their forests, and get little income from the resource (fig. 7). Yet it is land unsuited for any other purpose. The landowner is the key individual in getting acceptance of recommended forestry practices but his characteristics are poorly understood by governmental and educational agencies. His attitudes, motivations and competence need better understanding. In the Central States,

little is known about owner attitudes toward forestry programs, including public subsidy, extension methods, and other economic incentives. Length of tenure is a special problem.

Figure 1. PERCENT OF LAND FORESTED BY COUNTIES

(Source: Forest Survey Reports of Central States)

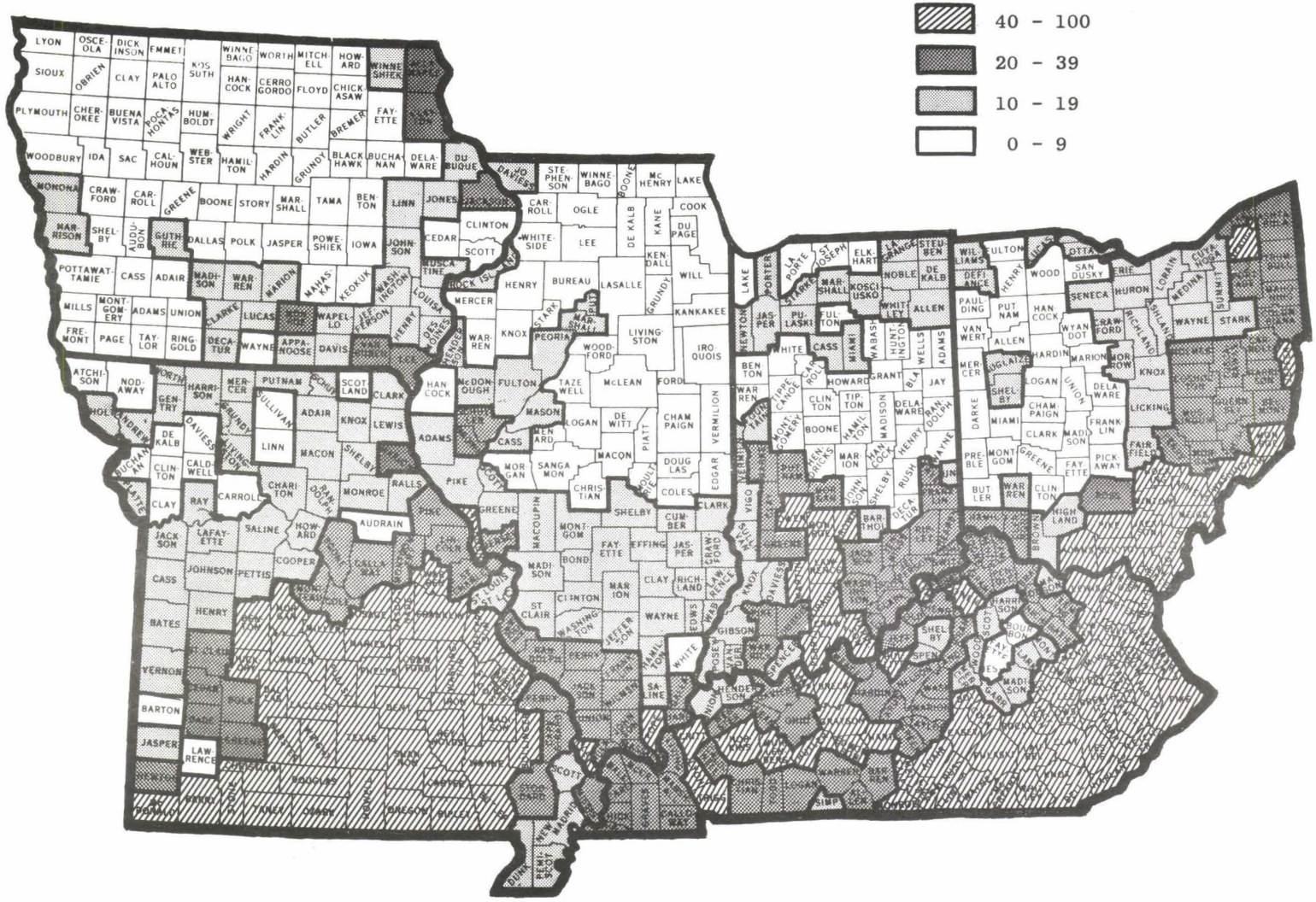


Figure 2. **NET VOLUME OF SAWTIMBER BY COUNTIES**

(Source: Forest Survey Reports of Central States)

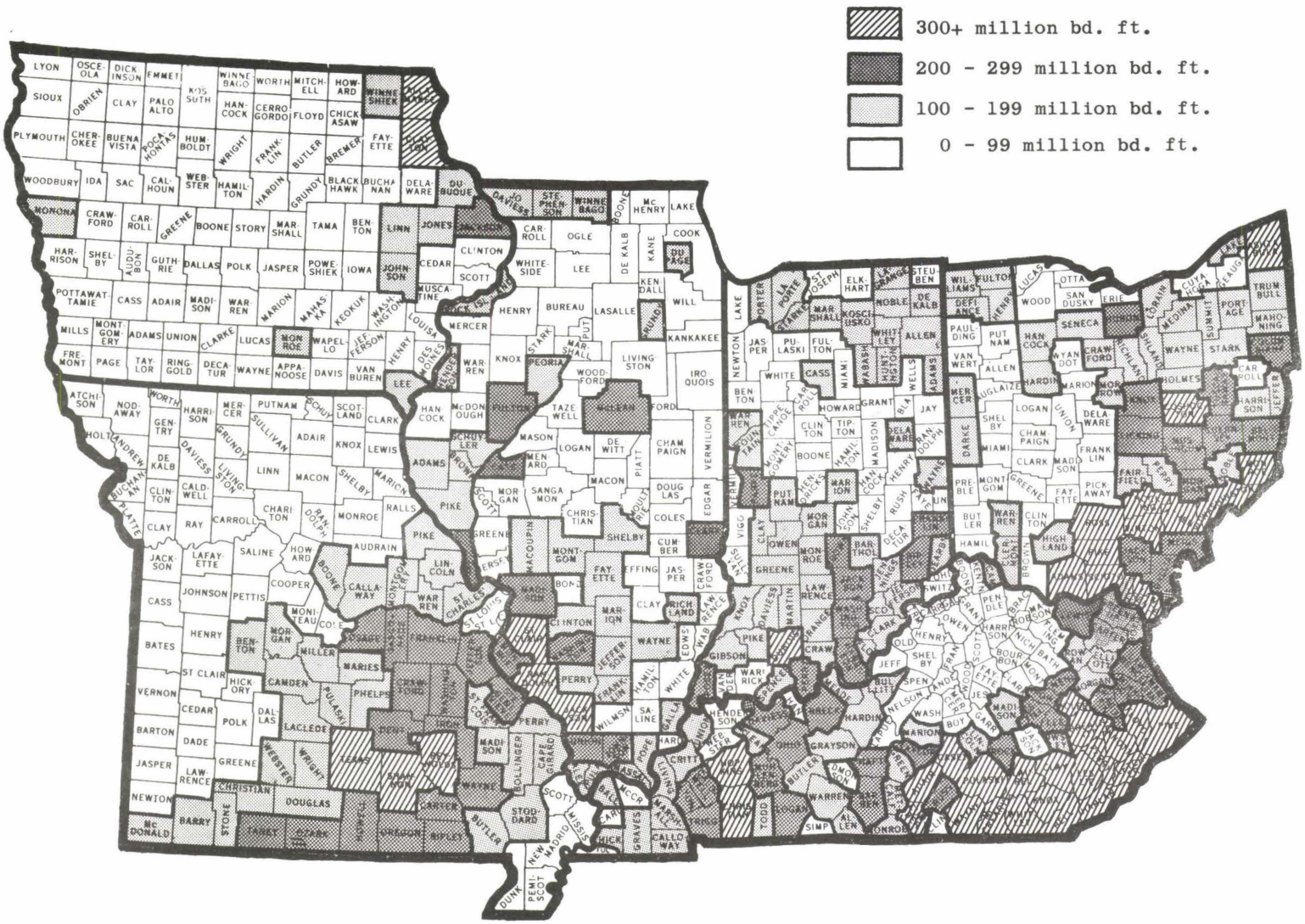


Figure 3. **ANNUAL LUMBER PRODUCTION BY COUNTIES**

(Source: Census of Manufacturing--1947)

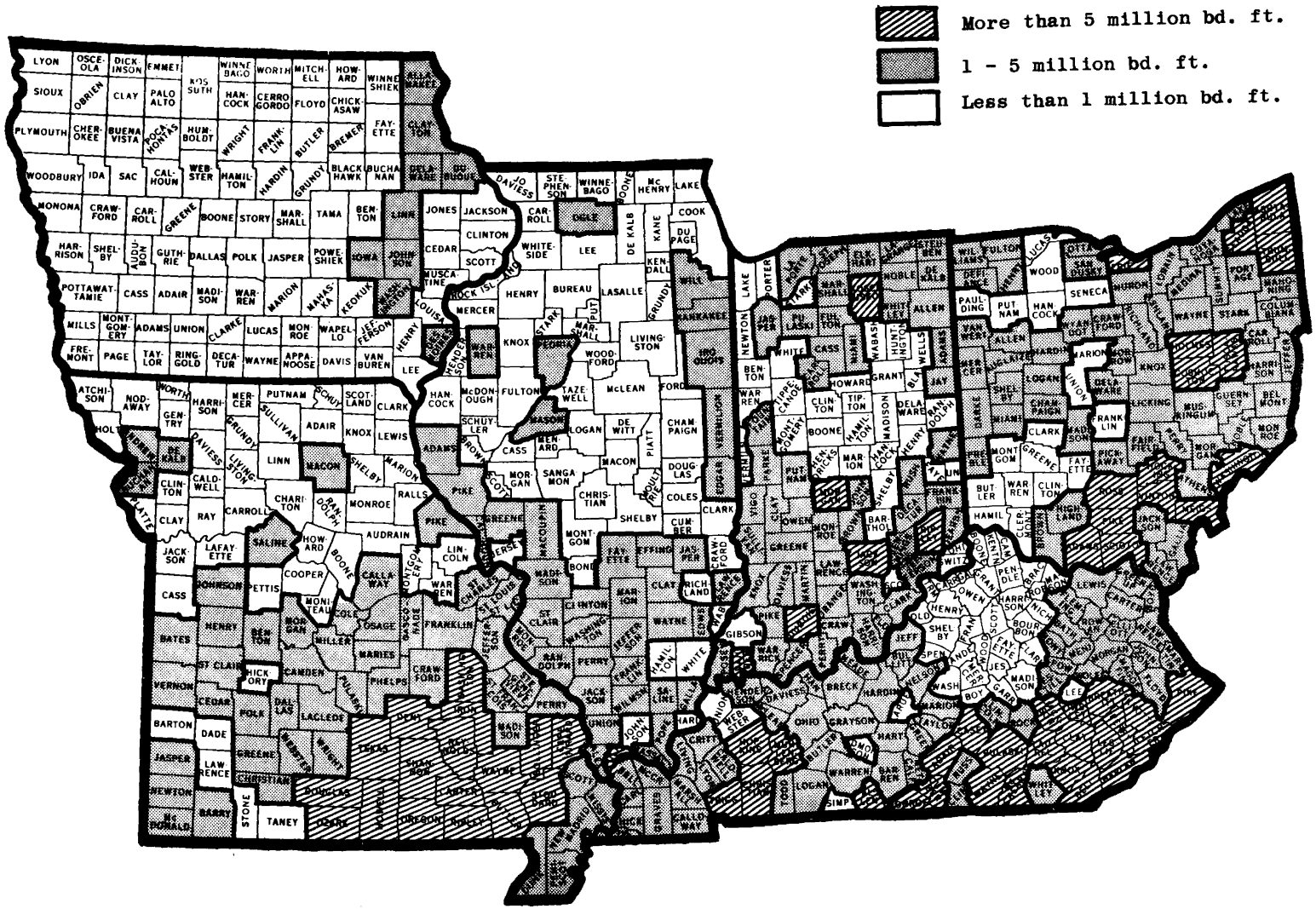


Figure 4. NET VOLUME OF CORDWOOD (6"-14" d.b.h.) BY COUNTIES

(Source: Forest Survey Reports of Central States)

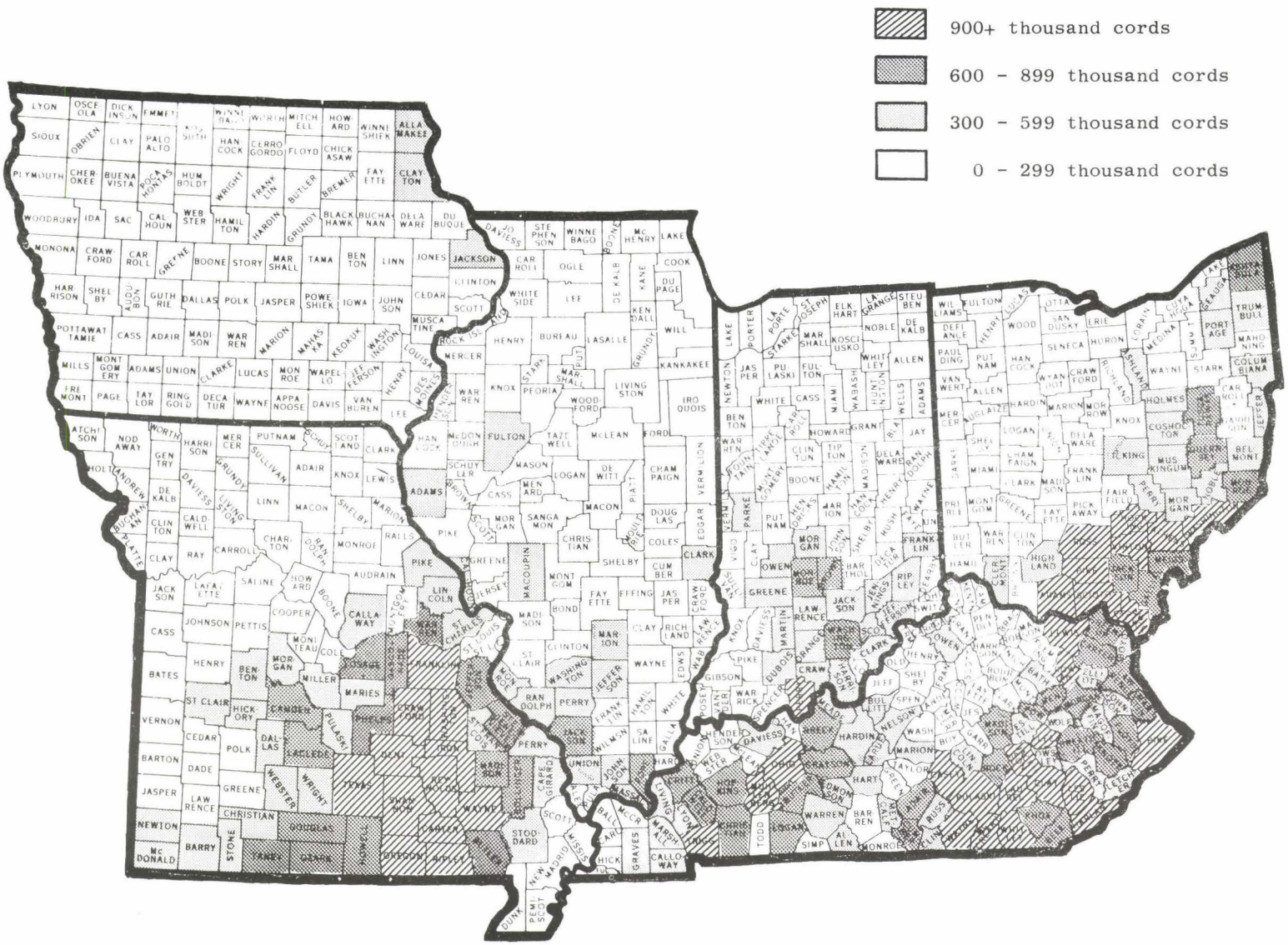
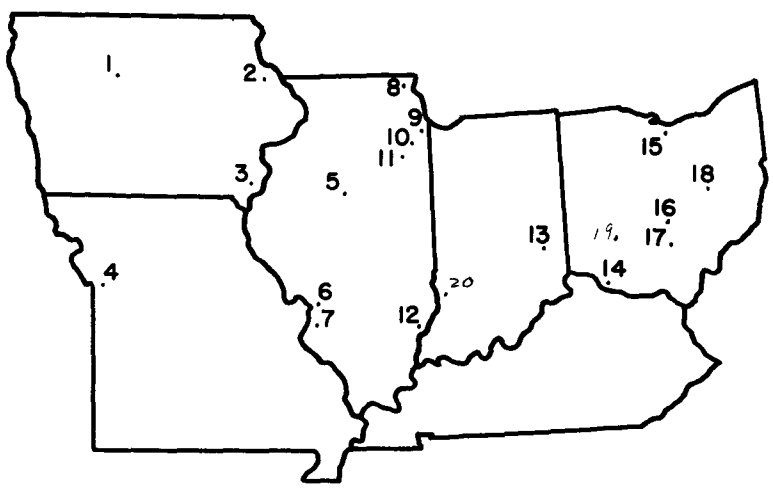


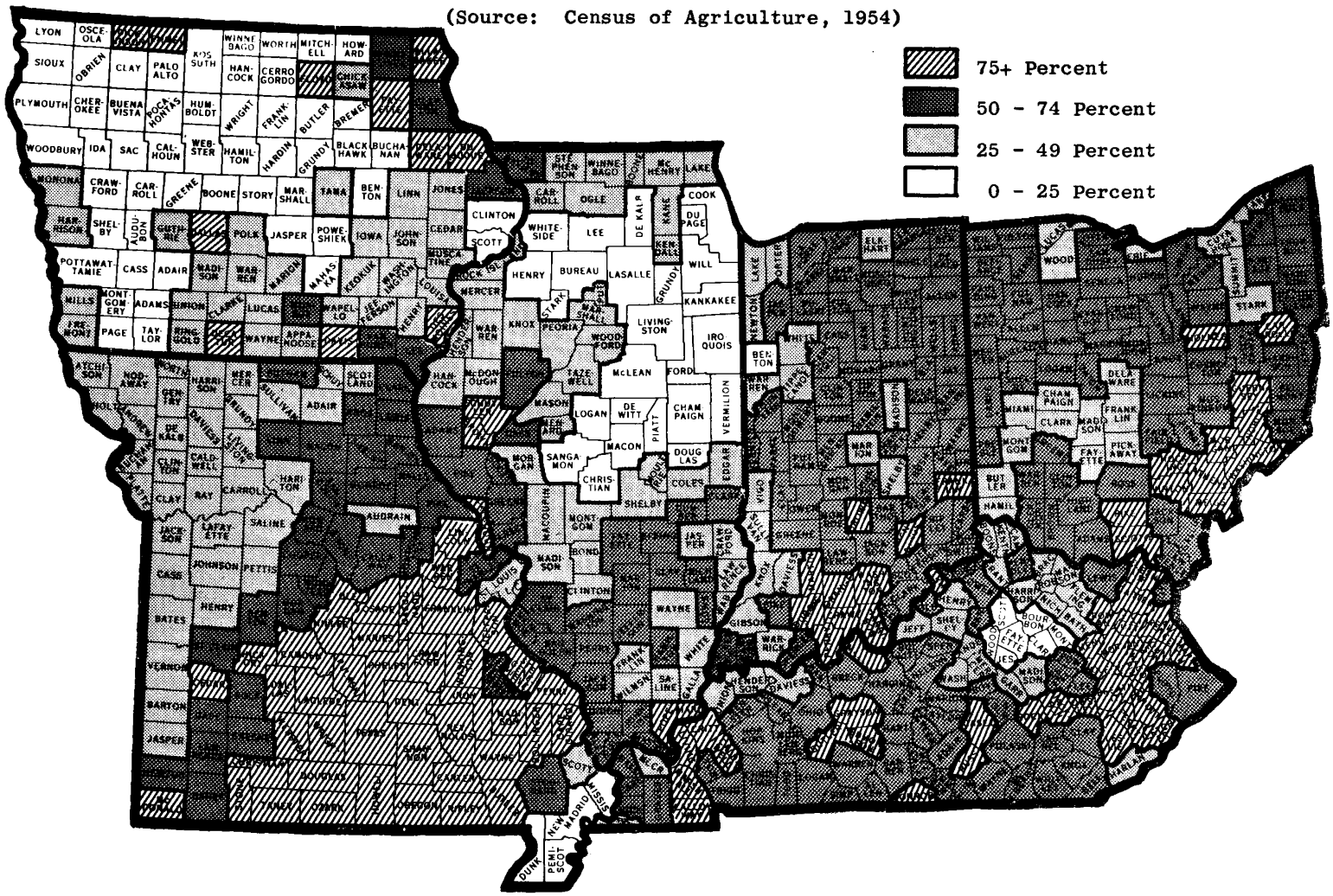
Figure 5.--Wood-Using Pulpmills of the Central States



NUMBER	MILL AND LOCATION	CAPACITY (Tons per day)
	Iowa	
1	United States Gypsum Company, Fort Dodge	Unknown
2	Barrett Division, Allied Chemical Corp., Dubuque	60
3	Crandon Paper Mills, Inc., Fort Madison	100
	Missouri	
4	The Ruberoid Company, Kansas City	75
	Illinois	
5	Barrett Division, Allied Chemical Corp., Peoria	180
6	Alton Box Board Company, Alton	50
7	Certain-Teed Products Corp., East St. Louis	75
8	Johns-Manville Products Corp., Waukegan	65
9	Globe Roofing Products Co., Inc., Chicago	34
10	The Ruberoid Company, Joliet	170
11	Lehon Company, Wilmington	70
12	The Flintkote Company, Mt. Carmel	70
	Indiana	
13	Container Corporation of America, Carthage	135
20	Weston Corp. Terre Haute	
	Ohio	
14	Phillip Carey Mfg. Co., Cincinnati	200
15	The Celotex Corporation, Avery	55
16	Container Corporation of America, Circleville	100
17	The Mead Corporation, Chillicothe	210
18	Stone Container Corporation, Coshocton	70
19	Logan - Long	

Figure 6. PERCENT OF FARMS WITH WOODLANDS BY COUNTIES

(Source: Census of Agriculture, 1954)

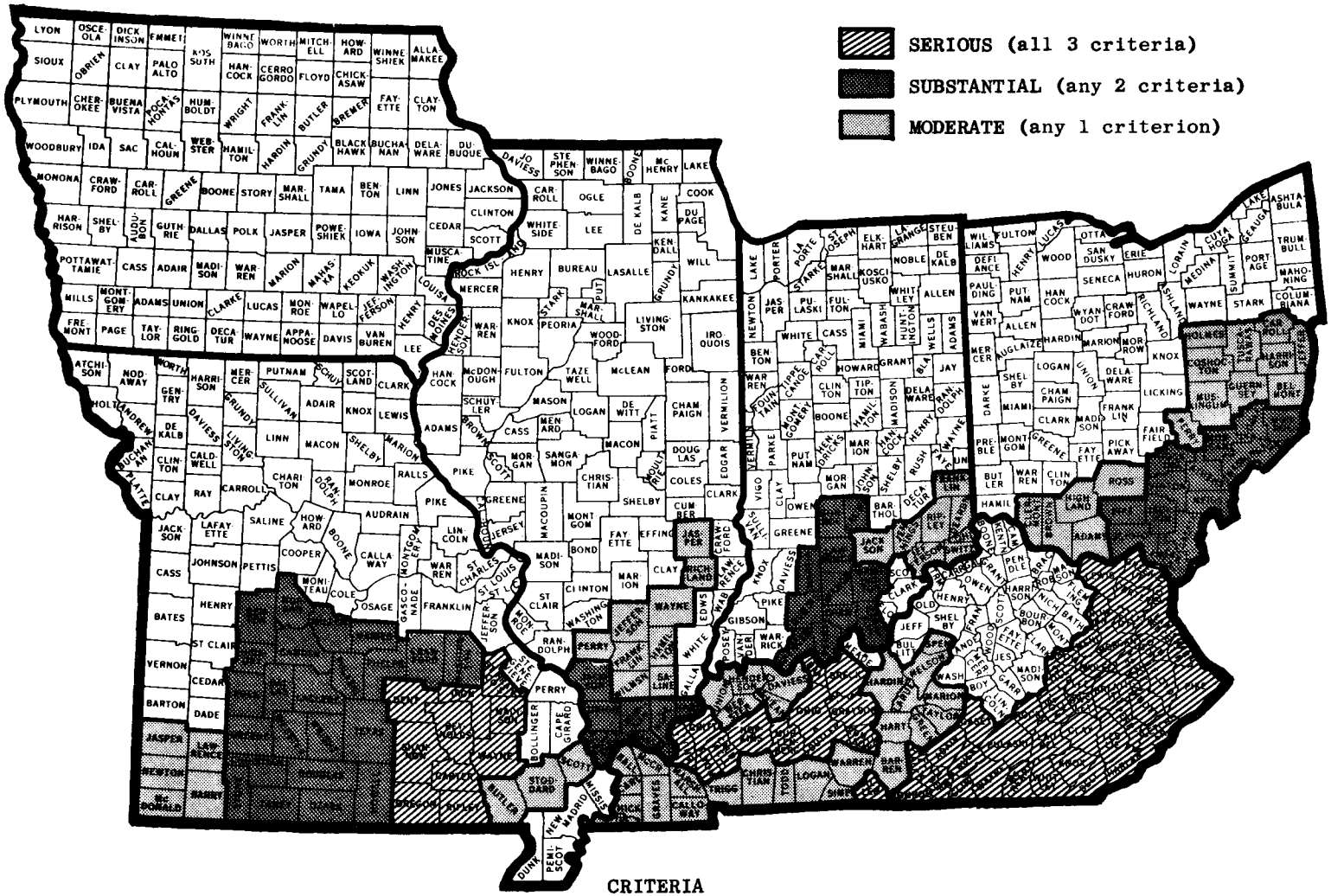


Total number of farms - 1,094,268
Total number of farms with woodland - 549,040
Total number of private owners of forest land[1] - 886,071

1/ Cent. States Forest Expt. Sta. Misc. Release 13.

Figure 7. COUNTIES WITH LOW INCOME AND LEVELS OF LIVING

(Source: Development of Agriculture's Human Resources--USDA-1955)



CRITERIA

1. Less than $1,000 residual farm income to operator and family with level-of-living index below the regional average and 25 percent or more of commercial farms classified as "low-production."
2. Level-of-living index in lowest fifth of nation.
3. Fifty percent or more of commercial farms classified as "low production."

FOREST DISEASE RESEARCH
AT THE
CENTRAL STATES FOREST EXPERIMENT STATION

The Division of Forest Disease Research has responsibility for the following areas of research:

1. The role of environmental factors in inducing forest diseases.
2. The cause, spread, and pathogenic mechanisms of vascular diseases of forest trees.
3. Host-parasite relations in hardwood canker diseases.
4. The nature and importance of forest tree viruses.
5. Infection and rate of decay in eastern hardwoods by heartrot fungi.

We have concentrated our efforts in areas 1., 2., and 3. above, in the past, but expect to begin research in area 5 this year.

CURRENT RESEARCH

Our main research effort has been on oak wilt, a major threat to oaks in the United States, and on chlorotic dwarf, an unexplained disease of young plantation-grown white pine. Some research is being conducted on a new canker disease of yellow poplar.

Active Studies: -

A. Oak Wilt:

1. Evaluation of the effectiveness of presently used control measures in Eastern States, conducted cooperatively among three forest experiment stations and six states.

2. Determination of the importance of root grafts as avenues of disease spread.

3. Study of morphological variations in the pathogen.

4. Evaluation of the role of bark beetle galleries as a source of oak wilt fungus inoculum.

B. Chlorotic Dwarf of White Pine:

1. Evaluating the effect of fertilizers on inducing recovery in diseased trees.

2. Investigating moisture stress and the onset of disease symptoms.

3. Determining the relationship of seedling vigor to subsequent disease incidence.

4. Assessing the possible role of virus in causing chlorotic dwarf.

C. Yellow Poplar Canker:

1. Determining the causal agent by isolating and inoculating associated fungi.

2. Determining the influence of site quality on disease spread.

D. Fomes Annosus Root Rot: - Determining the effectiveness of chemical protectants for controlling Fomes annosus root rot in thinned shortleaf pine plantations.

E. Forest Disease Survey: - Identifying and evaluating reported forest disease problems.

F. Cooperative Work With:

1. University of Missouri--formal agreement in which the university supplies manpower and facilities.

2. Ohio Division of Forestry--land and trees.

3. Kentucky Division of Forestry--land, trees, and manpower.

4. North Central Regional Project NC-22--exchange of information and consultation.

MAJOR CONTRIBUTION OF COMPLETED RESEARCH

1. Small black and white oak bolts heavily infected with the oak wilt fungus have been sterilized by exposure to a saturated atmosphere of either methyl bromide or chloropicrin for 3 days and proplene oxide for 7 days. This suggests that fumigation will eliminate wilt in logs and lumber and render these products safe for export. Fumigation of veneer logs under a simple polyethylene cover appears possible and would be far more practical than heat treating or kiln drying.

2. The incidence of root-grafts under field conditions in Missouri, based on translocation of poisons, activated isotopes, and dyes from treated stumps to surrounding trees, is approximately 15 percent for black and white oaks. Only a few of these known root-grafts have served as channels of fungus transmission. This incidence of disease spread excludes root-grafts as an important avenue of local transmission. Other factors or agencies responsible for local spread are indicated.

3. We have found that oak wilt is much less virulent in trees of the white oak group than in trees of the red oak group. About one-half of infected white oaks recover while infected red oaks invariably die. Overcup oak, Quercus lycata, Walt., appears to be highly resistant to the disease.

4. Our studies have shown that the oak wilt fungus can invade all portions of black and white oak sapwood, and to a lesser degree, heartwood. Wood moisture is the primary factor limiting fungus survival, and the wood rays appear to be the main avenues of invasion.

5. Several treatments designed to control the spread of oak wilt, appear to be completely ineffective on the basis of completed research in Missouri and preliminary results of research now in progress in Kentucky.

6. The importance of chlorotic dwarf disease was demonstrated in a survey of 26,000 white pines in 43 Ohio state forest plantations. The average disease incidence was 7 percent in the 3- to 15-year-old plantations. No disease was found in plantations more than 15 years old. The symptom picture in chlorotic dwarf strongly suggested a virus relationship. However, a large number of successful side grafts made in 1958 on healthy 8-year-old white and Scotch pines with scions from chlorotic dwarf pines have not yet demonstrated a virus relationship.

7. We have found that yellow poplar canker is caused by Fusarium solani; this represents a new host-parasite relationship. The parasite is a relatively weak canker-producing organism except on weak host trees.

NEW RESEARCH OPPORTUNITIES

Research in forest tree diseases over the years has been concentrated largely in the applied phases. Recent advances in technology, resulting in new tools and techniques, now permit explorations into the mechanisms of interactions between plant and parasite. Such research will yield extremely valuable information fundamental to our

understanding of plants and diseases. We believe that basic research oriented to specific diseases and combined with applied research is the best way to solve our forest disease problems.

Here are what we consider to be outstanding opportunities for research at this station to contribute to control of important forest diseases:

1. Formulate Effective Oak Wilt Control Measures

   Two gaps in our knowledge of the epidemiology of this disease are major handicaps in arriving at satisfactory control methods. They are:

   (a) What is the "normal" incubation period for this disease and are infected trees important sources of inoculum during the period between infection and symptom expression?

   (b) What insects are important vectors of this disease and what is their principal source of inoculum?

   (c) How and in what form does the fungus spread in the tree?

   (d) What is the mechanism of action of the fungus--are toxins produced? How is the living host cell affected? What are the effects on the enzyme system?

2. Crystallize Some of the Woody Plant Viruses, such as Walnut Bunch Virus and Elm Phloem Necrosis

   None of the so-called yellows type viruses have yet been isolated and purified. Their size, shape, and properties remain a mystery and until this mystery is untangled control of these virus diseases will be delayed. Newly developed tools for protein research should help solve this problem.

3. Determine Immunization properties of harmless viruses.

It is known that infection of a plant with a given strain of a virus often prevents infection by another strain of the same virus. Thus, inoculation with a harmless strain of a pathogenic virus might be used to protect a tree from a damaging strain.

4. No virus diseases have been reported on Conifers--don't they occur or can't we recognize them?

Many obscure and difficult disease problems in conifers have been attributed to unfavorable environment, due largely to our inability to find an obvious parasite. Few attempts have been made to evaluate possible virus associations in such diseases. A search should be made for abnormal nucleoproteins in conifers and serological techniques should be tried in an effort to establish presence of abnormal proteins.

5. Search Out Environment-Pathogen Relationships.

Discovery of environment-pathogen relationship could lead to biological control of some diseases. This represents a fine opportunity for team research involving pathology, tree physiology and soils. For example, what are the effects of moisture stresses, nutrition, and tree vigor upon the incidence and spread of the chlorotic dwarf disease and of yellow poplar canker?

6. How Do Hardwood Canker Diseases Attack Host Tissues?

We know little about the activities of fungus pathogens in host tissues, their manner of penetration, cell to cell movement, action on living cells, and subsequent killing of

infected tissues. A knowledge of the chemical nature of parasitism is essential to the development of systemic fungicides or antibiotics for disease control. The use of tissue culture techniques appears to be of value in studies of this kind.

7. How About Hardwood Heartrots?

Only a few scanty surveys have been made of the hardwood heartrots in the Central States. The major decay organisms should be identified and isolated for extensive studies on their physiology and chemical activity both within and outside the living tree. We need to develop new techniques for detecting decay in living trees, possibly using gamma ray or neutron back-scattering techniques.

DIVISION OF FOREST INSECT RESEARCH
NORTH CENTRAL FOREST BIOLOGY LABORATORIES

It is the responsibility of the Division of Forest Insect Research to develop new or improved methods for controlling insect damage to forest and shade trees.

CURRENT RESEARCH

1. Methods for Measuring Changes in Insect Numbers

Our objective here is to develop reliable methods for measuring insect population levels and relating these levels to tree mortality or tree damage. The insects being studied are the pine tip moths and the tulip tree scale. These insects are quite different in their biologies and in the manner in which they attack trees. Statistically sound methods of sampling are being developed to determine seasonal and annual changes in insect populations, to relate these changes to tree damage and to assign the cause for fluctuations to known or unknown factors. We hope to develop sampling methods that a land manager can use, with very limited assistance from an entomologist, to determine when control should be started. A reliable method of measuring insect populations is also essential in research aimed at improving control measures.

2. New and Improved Methods for Direct Control of Tree Insects

Active studies in this field deal with: (a) using systemic materials for the control of pine tip moths and mimosa webworm; (b) evaluating insecticides and developing methods of application for the control of the European pine shoot moth and the Nantucket pine moth; and (3) determining the effectiveness of systemic

materials in preventing transmission by insects of the Dutch elm disease and elm phloem necrosis.

Studies of this nature are started with small scale laboratory experiments conducted under very carefully controlled conditions. The more promising materials found in the laboratory are then used in small field plots and finally the most promising are evaluated in pilot plots.

Materials used in these studies are not always poisonous; full consideration is being given to non-toxic materials that may prevent or reduce insect feeding.

3. New and Improved Methods for the Indirect Control of Tree Insects

Here we are studying: (a) the effects of stand density on borer damage to oak trees; (b) borer-resistance of black locust clones when planted on different sites; and (c) a virus disease specific for the European pine sawfly, an introduced pest of several important pine species.

The study of oak borers includes identifying the more important insect species; determining their life histories, habits and manner of attacking oak trees; and the effect on their abundance of certain management practices such as Sale Area Betterment and Timber Stand Improvement work.

The locust borer study consists of establishing randomized plantings of borer-resistant clones on different sites and in different geographical locations. Interplanted with these clones are borer-susceptible black locust seedlings.

The study of the European pine sawfly virus is aimed at improving methods of propagating, storing and distributing this most effective biological control agent.

4. The Role of Insects in the Spread of Tree Diseases

We have one active study in this field, namely the possibility that insects may be responsible for spreading the fungus that causes oak wilt disease. This work is aimed at developing a reliable technique for screening vector candidates and determining within limits their efficiency as disease transmission agents.

5. Cooperators

Although we have no active formal cooperative agreements, we do have many informal working arrangements which make possible much of the above research.

The Ohio Division of Forestry: - This agency has furnished, without cost to the Forest Service, men, machinery, and materials to make studies of insect populations, of insecticides, and of the sawfly virus.

The Ohio Power Company: - Furnishes land and labor to establish and maintain plots for the study of the locust borer and the testing of resistant black locust clones.

The Ohio Reclamation Association: - Same support as given by the Ohio Power Company.

The Ohio Agricultural Experiment Station: - Furnishes land and men to test black locust borer-resistant clones.

The U. S. Soil Conservation Service: - Propagates the black locust clones.

Numerous Chemical Companies: - Make available without charge new systemic and insecticidal materials. They have also done some analytical work when requested.

A FEW MAJOR ACCOMPLISHMENTS

1. A practical method for protecting elm trees against Dutch elm disease and elm phloem necrosis has been developed and is being used by many towns and individuals. Although this control has undesirable features it is the only proven method now available.

2. Experimentally two systemic materials have been proven effective against such insects as the elm bark beetles, the mimosa webworm, pine tip moths and certain spider mites.

3. A very efficient bioassay method has been found for determining what parts of trees are effected when treated with systemic materials.

4. Studies of the European pine shoot moth have shown that 6' X 6' plantings are less seriously damaged than 8' X 8' plantings.

5. A black locust selection has been found that is very resistant to locust borer attack. This selection is being used for stock in propagating clones for further study.

6. A virus disease specific on the European pine sawfly has been found. Experimental applications have protected red pine plantations against serious damage by this insect for over 5 years.

NEW RESEARCH OPPORTUNITIES

1. Biological agents offer one of the finest opportunities for controlling forest insects. But research must determine more definitely possible uses for such biological agents as insect disease, male insects made sterile by radiation or chemicals, and environmental changes (modifications in our silviculture and management practices). Many damaging forest insects cannot be controlled by application of the more commonly used insecticides.

2. Still other opportunities lie in developing better methods of measuring changes in insect populations and predicting when population changes will cause enough tree damage to warrant the use of controls.

3. Unquestionably we are going to have to depend, at least in part, on chemicals to control many forest insects. For this reason research should seek out more specific materials, especially chemicals that will not cause undesirable side effects to birds, fish, and wildlife. In other words we should find ways to use a rifle and not a shotgun as we must do today. Basic research on what happens to materials in both the tree and insect is a requisite to success here.

4. Greater knowledge of insect-host relationships might open new control horizons. For example, why do certain insects attack only certain trees? Do resistant trees have special chemical and physical characteristics that repell insects? Can these characteristics be transmitted to other trees?

5. Little is known about the role of insects in the spread of tree diseases such as oak wilt and Dutch elm disease. Precise determination of insect-tree disease relationships could create new opportunities to control serious tree diseases.

FOREST MANAGEMENT RESEARCH

AT

THE CENTRAL STATES FOREST EXPERIMENT STATION

Research in forest management is aimed toward improving the productivity of forests and forest land in the region. More than 95 percent of the original forest cover (see map) in the Central States consisted of hardwoods, our chief problem and commercial interest. Most of the land is still, potentially, more suited to hardwoods than to conifers. The relatively small percentage of area in conifers, some ten million acres, is nevertheless, of high economic importance and deserves a share of our research. Plantable lands (about eight million acres) were originally in hardwoods, but now are generally more suitable for conifers because of soil deterioration. For these reasons research in conifers demands more effort than this relatively minor conifer area indicates.

The following briefs our current research, summarizes recent major contributions, and reviews research opportunities.

CURRENT RESEARCH

Our forest management research program may be grouped into six major categories. These categories, with summaries of research in progress under each, are reviewed below.

1. Stand Density and Intermediate Thinnings as Related to Quality and Growth. The over-all objective of this research is to determine the

effects of various residual stand densities upon timber growth and quality. This work is providing valuable interim results and ultimately will furnish the basis for yield tables of managed stands. A series of correlated studies is now in progress in the following Central States forest types: white oak, upland mixed oaks, mixed hardwoods, and shortleaf pine.

The character of the mixed hardwood stands in the Central States is such that intermediate cultural operations are necessary to control density, species composition, and timber quality. Many studies have been installed dealing with methods and techniques of pruning and the use of selective chemicals (including aerial application) as tools to make more practicable the elimination of undesirable trees or the release of desirable trees.

2. Harvest Cutting. Studies dealing with harvest cutting systems in mixed hardwoods are underway. These include single tree selection, clear-cutting, group selection, and shelterwood. Our primary objective here is to determine the size of opening which will result in adequate stocking of desirable reproduction. Subsequent development of this reproduction will be observed for effectiveness of stand openings. Other aspects of these studies include (1) the control of undesirable reproduction through the use of silvicides and ground scarification, (2) changes in soil moisture, (3) tree quality, (4) mensurational investigations, and (5) effects of grazing and fire.

3. Soil and Site Evaluation, by Species and Types, as Related to Growth and Yield. Site evaluation studies based on soil and topographic factors are underway in southeastern Ohio, eastern Kentucky, and southwestern

Missouri. Our objective here is to determine the soil-site factors that are related to forest productivity so that site quality may be closely estimated on land where indicator trees and ground vegetation are absent. The results will provide a rational basis for selecting, establishing, and managing the species or timber types best suited to a particular area.

4. Seeding and Planting of Old Fields and Other Lands Deteriorated by Past Uses. More than fifty of our studies deal with seed treatments, direct seeding, planting stock quality (stock grades), species adaptability, site preparation, and planting methods. We are attempting to determine the most effective means of establishing a productive forest cover on some eight million acres of land better suited to timber than agricultural use. Because most of such land once produced good hardwoods and the major problems in forestation with conifers have been solved, most attention is now centered on regenerating the best hardwood species, such as white and red oaks, yellow-poplar, black walnut, sweetgum, ash, sycamore, etc.

Also, we are searching for species, regardless of present values, that will survive and develop into protective covers on acid spoils and badly eroded soils.

5. Tree Improvement Including Provenance Tests and Genetics. Studies in tree improvement are intended to produce, by testing of seed sources throughout the ranges of species and by crossing of parents with desired characteristics, planting stock best suited to the needs of timberland owners. Closely related to tree improvement research are studies designed to facilitate the efficient production of clonal materials by stimulating rooting of cuttings and by grafting.

Current provenance studies - seed sources - include shortleaf, white, jack, pitch, and loblolly pines; redcedar; yellow-poplar; and basswood. Cuttings from different sources of hybrid poplars and black locust are being used.

Inheritance studies on wood quality of cottonwood and hybrid poplars and development of yellow-poplar are being investigated.

6. Tree Physiology. Our studies in physiology are designed to relate behavior or response of both cuttings and rooted stock to certain physical and chemical treatments. These studies include:

a. In seeking a method to stimulate rooting, hybrid poplar cuttings were treated with hormones and planted to three depths.

b. Hybrid poplar cuttings - 3 clones - were made in three lengths and each length planted on four dates, in the spring at three week intervals, to evaluate treatments for root stimulation.

c. Effects of complete fertilizers applied to stands of pole-size hardwoods.

d. Effects of a growth retardant, Phosfon-D, on black locust seedlings.

e. Mineral nutrition of yellow-poplar seedlings.

7. Cooperation. Many studies of mutual concern are currently established under formal cooperative agreements with state universities and experiment stations, state divisions of forestry, national forest administration, wood-using industries and industrial associations. It would literally be impossible to conduct our present research program without the assistance of our numerous cooperators. Almost every study involves some type and

degree of cooperation in the form of quarters, study areas, supplies and material, data processing and computing services, and technical supervision.

MAJOR CONTRIBUTIONS OF PAST RESEARCH

Since the real growth of forest management research began with the development of National Forest Purchase Units in the mid-thirties, many results have led to standard practices on both public and private lands. Results came into use by two means -- through on-the-ground observations of research by forest managers and through publications. The following practices have developed from our research.

1. Stand Density. Our oldest formal stand density studies are only 10 years old, but results from them are being used in many instances in thinning and stand improvement operations on many public and private lands. Their application should yield more volume growth on fewer trees and higher quality.

Early results in stand density studies indicate heavy commercial thinnings in fully stocked stands do not appreciably affect total volume growth. Diameter growth on residual trees increased considerably after thinning. However, in low density hardwood plots, an increased number of branches have developed on the lower bole of some trees, indicating caution to the grower against extremely low stand densities, particularly with certain species. It appears at this stage that necessary improvement thinnings in most stands may be done without excessively adverse effects on quality.

2. Harvest Cutting Methods Principally as Related to Natural Regeneration and Composition. Studies in harvest cutting systems have shown that small groupwise or patch clear-cutting best favor the establishment and development of desirable natural reproduction. Some type of ground control in the form of discing or foliage spray may be necessary to assure desirable species regeneration. Individual tree selection, rapidly falling into disfavor, has failed to stimulate acceptable reproduction in hardwoods that are relatively intolerant to shade. Almost without exception extension foresters and other advisors to forest landowners are recommending -- after observing our cutting methods studies -- clear-cutting by small groups or patches. These same studies have also demonstrated that the individual tree selection method of harvesting, when applied to 1- to 3-year cutting cycles, is uneconomical and gradually dissipates the growing stock.

In the mid-thirties, we started research in different degrees of release of both planted and natural shortleaf pine from low grade overstory oak at different seasons of the year and by different methods of killing trees. Even before results of these studies could be published they were in wide use on national forest lands in Missouri. Today, lands better suited to shortleaf pine growth than to hardwoods are aerially sprayed with herbicides as soon as adequate pine reproduction is established. The present cost of this method of stand conversion is only a small part of the cost of hand methods.

Responding to public demands for guidelines on managing forest properties, especially farm woods, a bulletin for practitioners, "How to Farm Your Forests," was published; it proved to be a "best seller."

3. Soil and Site Evaluations by Species and Types as Related to Growth and Yield. Soil-site studies in mixed hardwood stands have shown that reliable estimates of site quality can be obtained from soil and topographic features. From these studies a "system of study" has resulted by which the factors of site may be related to species and forest types. Furthermore, the studies indicate that existing soil type descriptions must be refined on the basis of the factors that influence tree growth before soil types -- either singly or by groups -- become useful in classifying forest site productivity.

This work has been done in close coordination with the Soil Conservation Service in Ohio and Kentucky and university and state soils departments of these states. These agencies now recognize the weaknesses in present soil type descriptions for forest site classification.

4. Seeding and Planting of Old Fields and Other Lands Deteriorated by Past Uses. Twenty-three years ago research was begun to find ways of reclaiming stripped coal lands on the Wayne National Forest Purchase Units in Ohio. Because of the intense interest of coal mining associations in the work, the studies were expanded in 1945 cooperatively with industry to nine states of the Midwest. Several papers were published as results became available. This year USDA Agriculture Handbook #166 was published; it contains a summary and evaluation of all the work done and has become a "bible" on reclamation with much of the industry.

Most of the reclamation of stripped lands in the nine states has been guided by the results of our research. The coal industry is planting annually some eight million trees in this region, and keeping their programs in line with developments of the studies.

The publication of Agriculture Handbook #166 culminates the major part of this program except for minor special studies and plantation maintenance. Our efforts will now be turned to other studies.

Also, during the mid-thirties a research program was started on reforestation of old fields and other denuded lands better suited to forest than agricultural use. Because of soil deterioration on these areas, most planting sites were found to be better adapted to conifers, especially pine species, than hardwoods. Consequently, the reforestation programs have concentrated on conifers. A USDA bulletin manuscript, summarizing the work on both conifers and hardwoods for the region during the 25-year period, will be ready soon for the printing office. By keeping the public currently informed of the research findings, much of the information given in the manuscript has been in practice by public and private land managers for many years. Because of special interest in increasing the supply of black walnut for high value products, Farmers Leaflet #84 has been revised to bring planting guides for the species up to date.

As a result of over twenty years of research in direct seeding for establishing forest cover and reinforcing stands, significant success has resulted for shortleaf in its natural range. In practice it is cutting significantly the costs of forestation. Failure to control rodents has been the prime factor limiting comparable results among hardwoods.

After twenty years of field tests on planting stock grades, specific recommendations have been made for shortleaf pine and yellow-poplar. Nurserymen and users of planting stock are setting quality limits to be attained. As a result of better survival and growth, shortleaf pine seedlings with 3/20- to 4/20-inch caliper and 6- to 8-inch stems have produced more than twice the cubic volume of smaller seedlings in twenty years.

5. Tree Improvement Including Provenance Tests and Genetics. Although this program is relatively new, provenance tests on many sources of shortleaf and loblolly pines, eastern redcedar, and yellow-poplar strongly indicate that local sources and sources from comparable climates are superior in survival, growth form, and resistance to low temperatures.

NEW RESEARCH OPPORTUNITIES

Our best opportunities for further contributions in forest management research are given below.

1. Stand Density. An expanded effort in the field of stand density and thinning to all major forest types offers a real opportunity to make a significant contribution to scientific timber management prescriptions. Research in the field of stand density is old in agricultural crops but new in forest crops. With more than 50 percent of the timberland of the Central States in the sapling and small pole size, most of which has adequate stocking but undesirable species composition, growth, yield, and quality, density guides are surely needed to bring these stands into maximum production. Past research results have shown that maximum volume growth can be obtained over a rather wide range of stand densities;

but very little is known about the effects of various stand densities on hardwood quality growth. The fact that high quality hardwood trees of given species bring stumpage returns of five to ten times the stumpage of low quality trees adds to the importance of quality considerations in stand density studies.

2. Soil-Site. Past use of timberland in the Central States has resulted in stands which do not represent the true site potential. A method of site evaluation based on factors other than existing vegetation is needed. Timber management prescriptions, including stand density, for a given stand will depend to a large extent on the site capabilities. What is best in terms of cultural practices on a good site may not be true for a poor site. As in stand density work soil-site investigations should be extended to cover a wider scope of forest sites and types. These studies should be coordinated so that soil-site-yield relations can be determined; this is the primary basis for forest management.

Fundamental growth and yield information based on site potential and thinning prescriptions will give the forest land owners a sound basis for scientific timber management practices. This information is a basic requirement of wise multiple-use management.

3. Pine Management. Although research in the management of pine is just getting underway, the need to develop complete management systems to handle the significant acreages of growing plantations is fully appreciated. Some 500,000 acres of pine plantations were established in the 30's; these are now coming into commercial size. Many additional acres

are being planted annually; these will require management if they are to be kept at peak production.

Although research in hardwood management is our chief problem and responsibility, research in management of nearly ten million acres of pine, pine-hardwood, and redcedar cannot be ignored.

4. Artificial Regeneration of Hardwoods. As a general rule hardwood plantations have been failures on many sites. We are finding clues to the reasons for these failures but much research is needed to determine the exact factors to be considered to get successful hardwood plantations of desirable species such as black walnut, yellow-poplar, ash, sweetgum, red and white oak, and others. We know, in a general way, that soils, cover, aspect, climate, and rodents must be considered in hardwood plantings; but more basic research in physiology, soils, and ecology must be done to pave the way for reestablishment of successful hardwood covers.

5. Genetics and Tree Improvement. There is a real opportunity in the Central States for making a major contribution through Genetics and Tree Improvement research. This area is the heart of the high quality hardwoods; and the many veneers, cooperage, cabinet and specialty industries offer a profitable outlet for quality wood. As in other regions, we are just beginning our research in forest tree improvement and genetics. Enough has been found, however, to show that yields can be vastly improved by better selection of seed sources, the development and use of varieties and hybrids of superior growth rate and quality, and the use of high quality seed. We must expand our research efforts in seed-source or

provenance trials, the selection of superior trees as sources of seed and clonal material, the techniques of rooting, grafting, and pollination, and the development of seed production areas and seed orchards.

6. Physiology - Basic Research. The development of precise forest management practices hinges on basic knowledge in physiology, the physical and chemical processes related to the response of trees to environmental factors.

Our studies in tree nutrition and light have opened new avenues of applied research. We have gained new knowledge on the longer viability of yellow-poplar seed which has important silvicultural implications. In stand density studies we have found soil moisture to be a limiting factor in some areas. The occurrence of epicormic branches on certain trees while absent on others is an important factor affecting tree quality that needs further basic investigation to determine whether the cause is physiological or hereditary. Seed production and the occurrence of seed years is little understood.

We have only begun to realize the growth potential of our hardwood stands and sites. Yields can be substantially increased only when the proper balance of factors of the environment are known and applied. Not until these factors are better understood can sound management practices be given to forest land owners.

FOREST FIRE RESEARCH

AT

THE CENTRAL STATES FOREST EXPERIMENT STATION

The fire research program in the Central States is designed to analyze the fire problems and conduct research leading to solution of problems related to fuels, fire weather, and prescribed burning.

Our program began in 1951 in Missouri as a one-man project attached to forest management research; in 1957 it was increased to the present two-man staff. Our work is still confined to Missouri, but should be extended to southern Illinois and Kentucky.

The following is a summary of current research, recent contributions to fire control, and research opportunities.

CURRENT RESEARCH

1. Fuel

a. Stand improvement practices being used on thousands of acres of low-value hardwoods to release either planted or natural young shortleaf pine includes mechanical and chemical killing of cull trees. Such practices produce great quantities of fuels and create a major fire hazard. We are determining the duration of the hazard, the rate of deterioration of fuels by size classes, and the hazard peak of the duration period. Results will help both land managers and fire control personnel.

b. Correlated measurements of rainfall, soil moisture, wind, and relative humidity are being compared with fuel moisture to give a better clue to relations of environmental factors to fire danger.

c. We are determining the rate of deterioration of pine and hardwood slash in timber operations. As pine needles remain on slash for some time and constitute flash fuel, the duration-expectancy of this hazard is of concern to those responsible for fire control.

d. Hardwood litter accumulation is limited by high oxidation rates in the Ozarks. We are evaluating total litter accumulation, its annual variation, and its variation as related to both stand density and past stand management.

2. Fire Weather

Meteorological research includes: (a) cooperative work with the Weather Bureau Station in Kansas City to find correction factors applicable to forecasted wind velocities which are used to estimate wind velocities at fire danger stations; and (b) comparisons of air movements in the open and in forest stands. These studies will assist in developing, for local adaptation, a unified system of fire danger rating.

3. Prescribed Burning

a. A cooperative study to determine effects of a controlled burn on a 12-year-old pine stand was established on private land. The owner expects to use the results as a guide to more such fires on his property of some 136,000 acres. His aim is to stimulate pine reproduction.

b. Controlled burning in type conversion studies is underway in the southwestern Missouri glades area. In evaluating the comparative economics of growing timber and forage, aerial spraying with herbicides is used to kill the low-value oak stands before seeding to range plants.

Unless the litter is destroyed or removed after killing, seeding is somewhat ineffective. We are determining how much more effective seeding may become when preceded by controlled burning. Volumes and characteristics of fuels were a part of the basis for evaluating effects.

4. Cooperation

Relations with both private and public agencies are very good. Excellent cooperation is given by the Missouri Division of Forestry. The Division contributes $1000 annually to our fire research project. The only part of the project looked upon with disfavor is that of controlled burning; the State Forester and Forest Supervisor both believe that most of the Ozark landowners are not yet ready for such a move.

MAJOR CONTRIBUTIONS OF PAST RESEARCH

Because of the short duration and small size of our fire research project, contributions have been quite limited. However, a few significant findings have been made.

1. The fire control problems of Missouri and the factors contributing to them have been analyzed; a problem analysis, "Forest and Range Fire Problems of the Missouri Ozarks," is ready for publication.

2. Adaptation of fire danger ratings to the Missouri Ozarks for use by the Forest Service and the State of Missouri has been accomplished, consistent with standards used by Region 9.

3. Some fifteen technical papers have reported new information on local fire damage.

4. Perhaps one of the most effective parts of our work has been close contact with the local Forest Service and state fire control units and local landowners. Through demonstration and research plots, all have received benefit. Many of the past firm believers in burning have refrained from such practice for several years; these individuals are the chief supporters of an influential drive against indiscriminate burning.

NEW RESEARCH OPPORTUNITIES

Many opportunities lie ahead for research to contribute to the control and use of fire in the Central States. Here are the more significant ones:

1. As soon as feasible, a regionwide problem analysis will be developed. This will point up the fire control problems without detailed discussion and geographic limitation. Problems will be appraised priority-wise as a framework for a more comprehensive research project, and advantage will be taken of basic research conducted at the specialized fire laboratories.

2. Greater contributions can and will be made by narrowing the existing program to research in fuels, fire prevention, and prescribed burning techniques. A fire research scientist will participate in all studies dealing with prescribed burning, thus assuring that fire behavior will not introduce unacceptable errors.

3. There is now high interest in forestry among State and Forest Service personnel and industry in Kentucky. These interests may provide an opportunity to extend, cooperatively, our fire research project to include Kentucky.

4. State officials, wildlife groups, and recreationists are becoming increasingly concerned over the threat of fire damage to parks, recreation areas and to wildlife habitat. There are abundant opportunities for fire research to contribute to the protection and use of these forest land resources.

5. Information for the forest manager on effects of fire on regeneration, growing stock, organic matter content of soils, and water relations, as related to site, is grossly lacking. Opportunity should be taken of both controlled and wild fires to obtain additional knowledge on these aspects of forest land management.

FOREST PRODUCTS UTILIZATION RESEARCH
At
CENTRAL STATES FOREST EXPERIMENT STATION

Forest Utilization Research has responsibility for: (1) the Station's timber quality, primary and secondary utilization, and forest engineering research programs; (2) administration of the Hardwood Phase of the FS National Log Grade Project; (3) liaison between the Forest Products Laboratory and state and federal agencies, associations, and private industry; and (4) cooperative research and service-type programs in the fields of timber quality, forest product utilization, and forest engineering.

Our efforts are directed toward encouragement of complete and efficient wood utilization to increase cash yields to the timberland owners and establishment and improvement of wood-using industries in the Central States.

CURRENT RESEARCH

The more significant studies now in progress in primary and secondary utilization are listed below.

Primary Utilization

1. Developing tree grades for the commercially important hardwoods - thirteen species and species groups.

2. Evaluating three sizes of crawler tractors and ground, pan and sulky skidding for logging in upland hardwoods. This research will

yield guides for the selection and use of crawler tractors and supplementary equipment for logging hardwoods.

3. Determining the effects of crew size and organization, wood density of the species being cut, topography, and intensity of cut on felling and bucking time when using two types of chainsaws.

4. Assessing the effect of defect orientation and taper set-out on lumber grade yield when sawing red oak logs on a small circular mill.

5. Exploring the possibilities of reducing milling costs by using a bark router to remove dirt and bark in advance of the head saw when sawing yellow-poplar logs.

Secondary Utilization

1. Determining and demonstrating the possibilities for using paper and vulcanized fiber overlays on cottonwood lumber in different styles of siding for buildings.

2. Evaluating the influence of nail diameter, type of point, location, and spacing on the nailability of air-dry red oak lumber.

3. Investigating electric load cells that will withstand the extremes of temperature and humidity when used in a dry kiln to measure changes in moisture content in lumber.

4. Evaluating the comparative serviceability of pallets fabricated from three combinations of green and air-dry red oak lumber.

5. Assessing the feasibility of producing self-feeders for hogs from different grades of red oak lumber by different processing methods.

6. Evaluating hickory, preservative treated and untreated, for use as stadium seat slats.

7. Investigating the suitability of hickory and red oak lumber for picnic tables made according to Forest Service specifications for use in "Operation Outdoors."

8. Studying effect of tension wood in factory cuttings of red oak lumber for furniture parts.

9. Determining cutting yields from five grades of hard maple lumber and the possibilities of predicting yields by using electronic data processing machines.

Cooperation. Much of the research we are doing would be impossible without the assistance of interested public and private groups. Here is a partial list of cooperators and contributors: Southern Illinois University, Iowa State University, Purdue University, Caterpillar Tractor Company, Sahara Coal Company, Woods Charitable Fund, Inc., Hyster Winch Company, Homelite Chain Saw Company, Forest Products Laboratory, Shawnee National Forest, and the Fish and Wildlife Service.

MAJOR CONTRIBUTIONS

The following are a few examples highlighting the contributions of our utilization research and service programs.

1. In recent years, practically all strawboard plants in the Central States have converted to wood pulp--we know of six plants that have converted. The Division, participating with others at the Station,

has given the companies assistance in many ways, ranging from technical processing information to actual assistance in locating outlying chipping plants. For example, we assisted the Alton (Illinois) Box Company in locating two chipping plants in southern Illinois. These plants are using both National Forest and private timber. These developments have increased substantially the bulk outlets for low-grade stumpage and are aiding many local communities.

We also helped establish a wood-using industry at Galconda, Illinois. This is now a thriving operation contributing to the economy of a low-income area. Currently, we are working with a community in southeast Missouri that is attempting to finance locally another wood-based industry. Our Wood Products Pilot Plant at Carbondale, Illinois, serves as a focal point for much of this work where many industry representatives come for information and guidance on equipment and processing methods.

2. We have assisted several State Foresters and Extension Foresters in conducting training schools in efficient sawmilling and air-seasoning practices (6 schools in 1960); have given technical assistance to many individuals in sawmill layouts and practices; and have conducted log grading schools for personnel of the Cumberland and Wayne-Hoosier National Forests.

3. Black oak tree grades have been developed and evaluated for application in the Central States. These grades give satisfactory

predictions of yield and now are used by Region 9 to evaluate stands being readied for sale.

4. We have developed, through research, a simple inexpensive jig for stacking lumber for seasoning and evaluated roofs on lumber stacked for air seasoning. Although we have no way of determining industrial uses being made of these innovations, we have had numerous requests for publications describing the jig and use of lumber pile roofs.

5. During the past five years the Division has authored 15 publications and co-authored 9 others with personnel in the Station's Forest Management and Forest Economics Divisions, at the Forest Products Laboratory, and at the Southeastern Station.

6. Late last year the Station undertook distribution of Forest Products Laboratory publications to interested parties within the Station's territory. A mailing list of 818 persons has been assembled and 32,505 copies of FPL publications were sent out the first eight months of calendar year 1960.

NEW RESEARCH OPPORTUNITIES

Forest product utilization research in the Central States is so new and virtually untouched that we are, in many ways, pioneering. A few of the outstanding opportunities for research to contribute to complete and efficient utilization are listed here.

Forest Engineering. Undoubtedly one of the finest opportunities for us lies in engineering research. Complete mechanization within a

cost range and size class consonant with small operations will be the salvation of the Central States' logging, sawmilling and forest management. Mechanization should be directed toward better multiple use management of our forests and improvement of the local economy through broadening the margin of profit for the timberland owner and the operator. Furthermore, it must make possible the profitable harvest and bulk use of small and low-grade trees. Research here should be of revolutionary nature--visionary, original, new equipment and methods unfettered by the present. It should include all phases of primary utilization--road construction, felling, bucking, chipping, sawing, and transporting products--as well as forest management and silvicultural operations such as planting and pruning.

Sawmilling. The thousands of small sawmills in our area present a real problem. Many are poorly financed, intermittent operations producing very poor quality lumber. Here is a second opportunity for research to help the industry do a better job and to encourage larger, better financed operations.

Seasoning. Hardwoods are difficult to season without loss of quality. The comparatively new development of forced-air drying prior to kiln drying should be investigated to determine its potential in drying hardwoods.

Use of Hardwoods. Research in product development offers an excellent opportunity to maintain demand for hardwoods as well as to

put them to uses for which they are either best suited or can be adapted through treatment. For example, can the good characteristics of hardwoods be improved by modifying their physical qualities by the addition of chemicals such polyethylene, by lamination, by preservative treatment, by fire-proofing? Can machining, processing, treating, and laminating methods be improved? The Station can best contribute to these opportunities through cooperation with the Forest Products Laboratories, research at universities and private institutions, and by making pilot studies of new products and processes. Our facilities at the Wood Products Pilot Plant offer fine opportunities for pilot plant investigations of production methods.

RANGE, RECREATION, WILDLIFE HABITAT AND WATERSHED MANAGEMENT RESEARCH

The objective of this relatively new division is to develop knowledge that will aid in:

I. Increasing the amount and quality of water yield.

II. Improving and efficiently utilizing forest forage and wildlife habitat resources.

III. Improving and expanding forest recreational opportunities.

CURRENT RESEARCH

Research is now concentrated on range and watershed management.

Watershed management research is directed toward discovering basic principles of watershed processes and developing methods of protecting, improving, and managing watersheds. It includes studies on:

1. Effects of forest and range cover (and their harvest or use) upon the water resources.
2. The soil stabilizing qualities of various plant species.
3. The effects of soils and vegetation upon streamflow.
4. The physical laws governing the relation of precipitation to water movement under natural and altered watershed conditions.
5. Methods of increasing water yield and quality.

Range research in progress includes:

1. Devising plans for improving, maintaining, and efficiently utilizing livestock forage through the use of one or more of the following: Better grazing practices, more uniform utilization, aerial spraying of herbicides, and controlled burning.
2. Improving or maintaining the habitat of game animals.

3. Determining forest land use capabilities.

4. Increasing knowledge of the taxonomy, ecology, and physiology of range plants.

5. Developing measurement and evaluation techniques for rangelands.

These investigations are conducted cooperatively with:

1. Muskingum Watershed Conservancy District: Measuring streamflow and subsoil movement from watersheds and plots under varying climatic and management conditions.

2. Region 7, Region 9, and U. S. Geological Survey: Observing the effects of strip mining and acid mine discharge on yield and quality of water.

3. University of Missouri: Studying the taxonomy and ecology of Ozark range plants and the production of mast pin oak as a food for ducks.

4. Iowa State University: Tracing the ecology of native prairie and developing statistically sound methods of measuring understory vegetation.

5. National Forest Administration, Missouri National Forest: Determining practical methods of increasing native Ozark forage.

6. Agricultural Research Service, Crops Research Division: Measuring forage and timber production under various treatments on poor, medium, and good, western-Ozark forest sites.

7. Wildlife Investigations Sections, Missouri Conservation Commission; and Fish and Wildlife Service, Missouri Wildlife Research Unit: Recording the effects of deer browsing on vegetation and the response of forage to timber harvesting.

MAJOR CONTRIBUTIONS OF COMPLETED RESEARCH

Watershed Management:

1. Precipitation and runoff records for three small watersheds near Rolla, Missouri, were analyzed. Annual water yields and annual precipitation were found to be highly correlated and both fluctuated widely. In a 7-year period the smallest watershed had 96 peak flows exceeding 40 c.s.m. (cubic feet per second per square miles) while the middle sized had 65 such peaks and the largest only 44. These results imply that highway bridges and culverts at the mouths of small watersheds may require as much capacity as those serving watersheds 10 to 20 times larger.

2. Water yields have been reduced by forest plantings made on two-thirds of a 43.6 acre watershed in southeastern Ohio. Once farmed, grazed and badly eroded, the watershed was planted to trees in 1939. Water retention and detention properties of the watershed were improved but more water was transpired as the plantation developed. Regulation of streamflow and a considerable reduction in the total annual water yield became apparent after the sixth year, the time when tree crowns closed. This is one the few studies in the Central States area that shows the effects of afforestation upon water regimes.

3. To obtain information in the 30-45 inch rainfall belt of the United States on water use by different types of vegetation, the moisture content of a shallow soil was measured for 22 months in southeastern Ohio on oak, pine, grass, brush, and cleared plots. Total water evaporated or transpired in a 6-month growing season ranged from 21 inches under cleared to 25 inches under pine. Pine used additional water during the

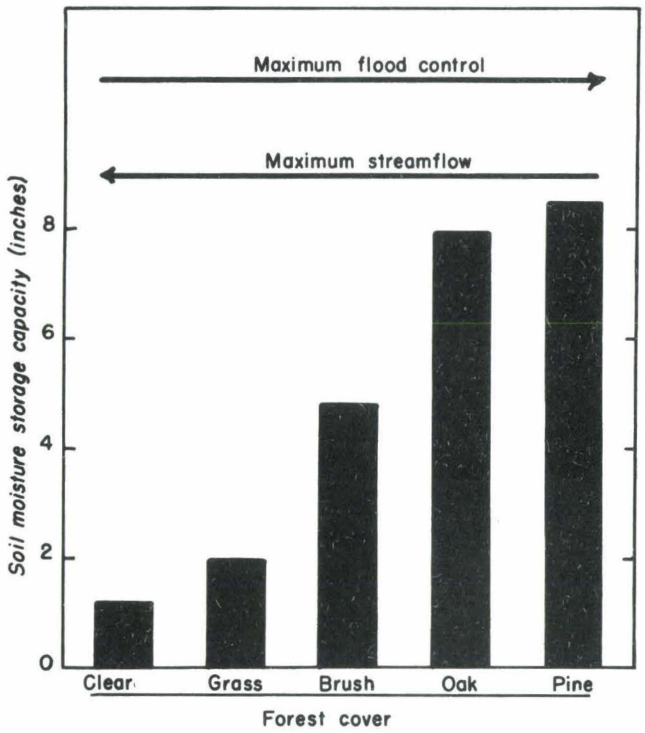


Figure 1.--Influence of forest cover type upon soil moisture storage capacity.

dormant season and the 2-year average amount of precipitation required to rewet the soil was 7.3 inches greater under pine than under cleared.

Even on these thin soils these results exemplify the two opposing objectives that may be proposed for a watershed management program: (a) the possibility of increasing streamflow by decreasing transpiration through cover manipulation; and (b) decreasing floods through the maintenance of a heavy growth of vegetation. From this study, increased streamflow would be expected through conversion from pine, to oak, to brush, to grass, to cleared and increased flood control benefits would be expected by proceeding in the opposite direction (Figure 1).

4. Improvement in land use and vegetative cover on the watershed above Leesville Reservoir near Leesville, Ohio, reduced stormflow volumes, especially near the end of a 20-year study period. Winter flows declined most, fall and summer flows decreased lesser amounts, average annual flows trended slightly downward, but spring flows increased. Flows were reduced most for rainfalls of 1 to 2 inches less for storms of 2 to 3 inches. No meaningful change was found in any season for storms above 3 inches. The results of this analyses imply that as land management improves stormflows will decrease at least for the small and intermediate storms.

Range Management

1. A study on nutritive values of Ozark vegetation revealed that by mid-summer many native forage plants are low in certain essential nutrients. However, good Ozark range can provide cattle with adequate amounts of

nutrients until late summer because of the variety of forage species and the high quality of the regrowth.

2. The old-field native grasses, big bluestem and switch grass, were found to yield more forage than seeded orchard grass and K 31 fescue (up to 5,000 pounds of air-dry forage per acre as compared to 3,500 pounds per acre). Also the native grasses require less fertilizer.

A good range management scheme for the Ozarks is to plant native warm season grasses for use during the hot summer period, but to graze seeded, cool-season grasses in the spring and fall.

3. Herbicides are more effective than spring burning in permanently controlling unwanted hardwoods. However, controlled burning can effectively prevent red cedar encroachment on livestock range.

4. Timber harvesting and T.S.I. work on Ozark hardwood forests increased forage and browse production for as long as nine years. Herbage production was found to be inversely related to hardwood crown cover. Therefore, to obtain significant increases in herbage production, hardwood stands need to be thinned to below 50 percent crown cover.

5. A study on conversion from forest to range revealed that one acre of cleared forest land can produce more forage than 50 to 100 acres of a well-stocked, timber stand. However, for the converted land to produce this much forage it is necessary to have a good nucleus of desirable grasses before clearing or to seed some adapted species and perhaps to apply fertilizer on the cleared land. Also, even after the land has been cleared, seeded, and fertilized, keeping it free of woody plants may require considerable maintenance work.

NEW RESEARCH OPPORTUNITIES

The Central United States is often thought of as a humid, well-watered, heavily populated area where forest grazing and timber production are of minor importance. However, the rapidly increasing population is placing new demands upon the forests, is creating new problems or intensifying old ones, and is providing greater opportunities for research. Here are a few of the major opportunities for this division to contribute to better forest land use in the Mid-West.

1. In the field of watershed management: (a) determine the basic hydrologic processes that occur on forested and urban watersheds and on areas mined for coal, oil, or gas; (b) evaluate the hydrologic changes that occur when depleted slopes are revegetated; and (c) help develop watershed management practices harmonious with other forest land uses.

Urban and industrial development in the Central States is creating a growing demand for water. Paradoxically, such development is also creating problems in disposal of used water (lowered in quality) or of water falling on newly-constructed, impervious surfaces such as roofs, streets, and parking lots. Watershed management research can make its best contributions by first, developing an understanding of the hydrologic processes and the effects of land use upon them and second, from this knowledge deriving methods of controlling the processes.

2. In range management research: (a) develop and evaluate efficient and practical livestock grazing methods; (b) intergrate grazing with other forest land uses; (c) establish criteria for judging Ozark forest land capabilities; and (d) determine practical methods for converting forest vegetation to range types.

The natural tendency of much of the uncultivated range lands of the Ozark portion of the Central States territory is to produce worthless shrubby vegetation or small quantities of low-value, forest products. The returns from this land can often be increased many fold by converting the vegetation to a high quality, high-yielding, forage type. Such conversion, however, is sometimes hard to accomplish and maintain. Hence, the greatest range management research opportunities lie in discovering the optimum capabilities of the uncultivated areas and then establishing and maintaining these uses.

3. Wildlife habitat research needs to: (a) unite game habitat production plans with those for other forest uses; and (b) perfect ways and means of maintaining and improving the wildlife habitat in productive condition while under use.

Although big game animals are rather scarce, the forest lands and waters of the Central States area do produce great quantities of fish and many small birds and animals that are hunted for food and sport. Much of the natural habitat of these wild animals is being devoured or despoiled by the industrial and urban development within the area. Protection and improvement of present areas and substitution or creation of new ones will be urgently needed within the foreseeable future. Research undertaken now will help guide these future developments.

4. Recreation research should: (a) evaluate opportunities for small woodland owners to supplement forest income through sale of recreation resources; (b) to appraise the sociological aspects of short-term and week-end recreationists; and (c) work with the Mid-Western Universities in researching the recreationists themselves.

The Central States is unique in the pattern of forest land ownership, in the predominantly heavy demand for short-term and week-end recreation opportunities and in having a concentration of strong institutions of higher education. These characteristics provide excellent opportunities for recreation research--especially research in human motivations--to contribute to forest recreation developments in the Mid-West as well as in similar, adjacent parts of the Nation.